Chapter 3
Water Quality Monitoring, 2001-2002

Introduction

Water quality monitoring from 2001 to 2002 continued according to the amended protocol implemented by the California Department of Water Resources (DWR) in 1996. As described in the 1996 Water Quality Report (Lehman et al. 2001), the number of discrete water quality sampling sites was reduced to 11 representative sites. Discrete samples were taken monthly at each site (Figure 3-1). Data were recorded within one hour of high slack tide and the time of each sample was recorded to the nearest five minutes of Pacific Standard Time. A qualitative statement of weather conditions (i.e., wind conditions and cloud cover) was recorded for each cruise. Samples were analyzed for the15 physical and chemical parameters shown in Table 3-1. The complete database is available online at http://baydelta.water.ca.gov.

Figure 3-1 Water quality monitoring stations

Table 3-1 Water quality parameters measured

Parameter	Units
Water temperature	°C
Dissolved oxygen	mg/L
Specific conductance	µS/cm
Secchi disk depth	cm
Turbidity	NTU
Orthophosphate	mg/L
Total phosphorus	mg/L
Kjeldahl nitrogen	mg/L
Dissolved inorganic nitrogen	mg/L
Dissolved organic nitrogen	mg/L
Total dissolved solids	mg/L
Total suspended solids	mg/L
Volatile suspended solids	mg/L
Silica	mg/L
Chloride	mg/L

As shown in Table 3-2, eleven sampling sites are used in this study to represent eight regions of the Bay-Delta system. Water quality conditions in each of six regions are represented by a single sampling site. The south Delta and Suisun Bay, however, are represented by two and three stations respectively.[1] In previous reports, data from multiple sample sites within each region have been averaged according to the hierarchical cluster analysis protocol; however, for clarity, data results in this report are shown for each sample site.

[1] An exception to this protocol exists for Secchi disk depth measurements for the south Delta region. Secchi disk depth measurements for this region are represented by a single sampling at Site P8, as no Secchi disk depth measurements are made at sampling Site C10.

Table 3-2 Water quality sampling sites and regions

Region	Sampling sites
Lower Sacramento River	D4
Lower San Joaquin River	D26
North Delta	C3
Central Delta	D28A
East Delta	MD10
South Delta	C10 and P8
Suisun Bay	D6, D7, and D8
San Pablo Bay	D41

Parameters Measured

Except where noted, all discrete water quality samples are obtained with shipboard sampling equipment using DWR's research vessel, the *San Carlos*. Supplemental discrete samples are taken with mobile laboratory equipment at sites in the south Delta (C10 and C3) that are inaccessible to the vessel *San Carlos*. Secchi disk depth is not taken at site C10 due to restrictions of the sample site, which requires sampling equipment to be deployed from a bridge 50 feet above the water's surface.

Water Temperature

Water temperature was measured in degrees Centigrade (°C) with a YSI thermistor. For all sites except the south Delta, temperatures were measured from water collected from a through-hull pump at a depth of 1 meter. In the south Delta, temperatures were measured by submerging the YSI thermistor to a 1-meter depth.

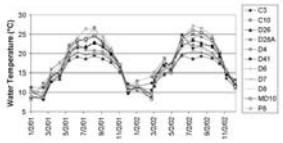

Figure 3-2 Bay-Delta temperatures, 2001-2002

The minimum water temperature for the 2001- 2002 period, 8.1 °C, was recorded in at station C3, in the north Delta (Figures 3-2 and 3-3). This minimum represents an increase of 1 °C over previously recorded minima for the 1997-2000 study period (Gehrts et al. 2003).

The maximum water temperature for the 2001-2002 period, 27.2 °C, was recorded at station P8, in the south Delta. This recorded maximum represents an increase of 0.3 °C over previously recorded maxima for the 1997-2000 study period (Gehrts et al. 2003).

In comparison with water temperatures recorded during the 1997-2000 study period, the coldest water temperatures during the 2001-2002 study period occurred later and the warmest water temperatures occurred earlier (Gehrts et al. 2003). Recorded temperatures exhibited strong seasonal variability, with waters cooling during the winter and warming during the summer.

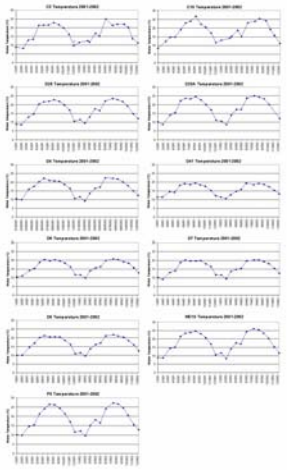

Figure 3-3 Temperatures at specific Bay-Delta sampling sites, 2001-2002

Dissolved Oxygen

Dissolved oxygen was measured using the modified Winkler iodometric method described in Standard Methods (APHA 1992). A sample aliquot was collected from a through-hull pump or from a grab sample, at a depth of

1 meter. The samples were collected in 300-ml glass-stoppered bottles and immediately analyzed onboard.

During the study, dissolved oxygen concentrations ranged from 3.7 mg/L at site P8 in the south Delta in December 2002, to 12.5 mg/L at site MD10 in the east Delta in February 2001 (Figures 3-4 and 3-5). Strong seasonal trends were evident in most regions, with dissolved oxygen concentrations decreasing during the summer and rising in the winter. At sites exhibiting noticeable seasonal changes (C3, D26, D28A, D6, D7, D8), dissolved oxygen levels showed good correlation with changes in water temperature. The decline in dissolved oxygen during increasing summer water temperatures very closely matched the linear function for the decline in oxygen saturation capacity as a function of temperature. This suggests that dissolved oxygen levels at many sites tend to be influenced largely by physical processes (such as temperature and saturation capacity) rather than biological processes (such as respiration and primary production). An exception to this was noted at sites P8 and C10 in the south Delta. Both sites showed poor correlation between temperature and dissolved oxygen levels, and little seasonal patterns. These sites also showed the greatest degree of variability in dissolved oxygen levels, ranging by almost 8 mg/L over the year.

Representing the Suisun Bay, sites D6, D7, and D8, were closely related and showed a yearly variation of about 2 mg/L, which was consistent with the range observed at most other sites.

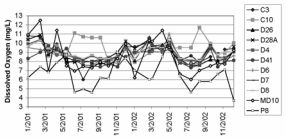

Figure 3-4 Bay-Delta dissolved oxygen, 2001-2002

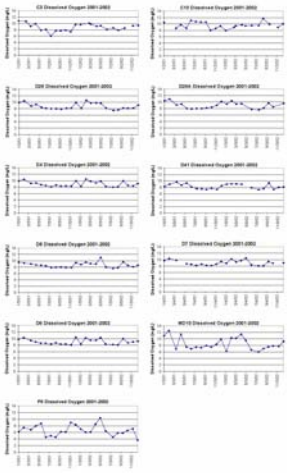

Figure 3-5 Dissolved oxygen in the Bay-Delta, 2001-2002

Specific Conductance

Specific conductance, an estimate of salinity, was determined from samples collected from a through-hull pump at a 1-meter depth. The samples were analyzed for specific conductance using a Seabird model CTD 911+ data logger. Measured values were temperature-compensated to 25 °C.

Specific conductance varied greatly between sites monitored, ranging from 74 µS/cm at site D26 in the lower San Joaquin River in December 2002, to 45,107 µS/cm at site D41 in San Pablo Bay in November 2001 (Figures 3-6 and 3-7).

Specific conductance generally increased from east to west and was well correlated to inflows and tidal action. Maximum values occurred in the late summer and fall when flows through the Delta were low and marine intrusion was more pronounced.

Sites with high, average, specific conductivity (such as D4, D6, D7, D8, and D 41) tended to show stronger seasonal variations, with specific conductance varying from a low in March to a high in November of each year. At sites with lower specific conductance, this seasonal trend was less apparent.

Specific conductance dropped noticeably at all sites in January 2002. A similar decline occurred in March 2001. Downstream sites showed the most variability, especially during winter. Upstream sites with low specific conductance, such as site C3, had the least variation and did not show any apparent seasonal trends.

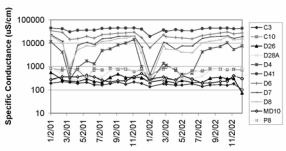

Figure 3-6 Bay-Delta specific conductance, 2001-2002

Figure 3-7 Specific conductance in the Bay-Delta, 2001-2002

Secchi Disk Depth

Water transparency was measured to the nearest centimeter using a 20-cm diameter Secchi disk attached to a 2.5-m rod marked in cm. Secchi disk transparency was recorded as the average depth at which visual determination of the disk was lost as it was lowered into the water column, and the depth of its visual perception as it was raised. All measurements were made from the shaded side of the vessel.

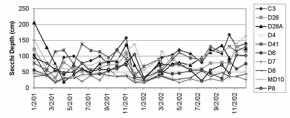

Figure 3-8 Bay-Delta Secchi disk depth, 2001-2002

A Secchi depth minimum of 160 cm was recorded at sampling sites D7 and D8 in the Suisun Bay during March 2001, December 2001, and January 2002 (Figures 3-8 and 3-9). A Secchi depth maximum of 206 cm was recorded at sampling site D28A in the central Delta in January 2001.

Secchi disk depth varied considerably between sites, with little apparent seasonal correlation. A marked decrease in Secchi depth occurred at all sites from December 2001 to January 2002. At some sites, such as C3, Secchi depth varied considerably. For example between November and December 2001, site C3 Secchi depth changed from 158 cm to 20 cm. By March 2002 the C3 Secchi depth had again increased to 96 cm. A similar decline and rebound occurred at several sites (C3, D26, D28A, D4, D7, and D8) during this general period between November and March.

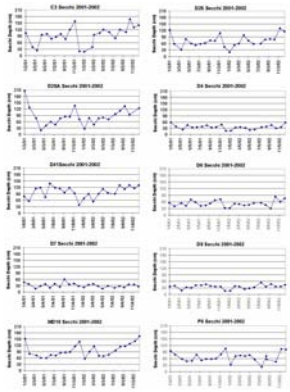

Figure 3-9 Secchi disk depth in the Bay-Delta, 2001-2002

Overall, Secchi depths were lowest at sites D6, D7, D8 and D4, while sites C3, D28A, and D41 had the highest overall average Secchi depths. As noted earlier, Secchi disk depth measurements are not taken at site P8 in the south Delta.

The long-term increase in transparency data noted in previous reports (Lehman et al. 2001) was not discernable in the 2001-2002 data.

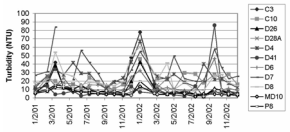

Figure 3-10 Bay-Delta turbidity, 2001-2002

Turbidity

Turbidity is a measure of the optical properties of water and substances contained in the water that cause light to be scattered and absorbed rather than transmitted in straight lines (APHA 1992). Turbidity is caused by soluble organic compounds, plankton, and suspended matter, such as clay, silt, inorganic substances, and organic matter.

Turbidity was determined from samples collected from a through-hull pump at a 1-meter depth. The samples were pumped through a Turner Model 10 flow-through nephelometer calibrated with a reference sample of formazin suspension at 40 nephelometric turbidity units (NTU) according to Standard Reference protocol 214-A (APHA 1992).

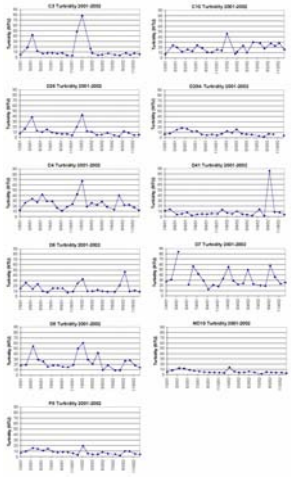

Figure 3-11 Turbidity in the Bay-Delta, 2001-2002

Turbidity varied greatly among sampled sites (Figures 3-10 and 3-11). Values ranged from 1.3 NTU at sites D41 and D28A (San Pablo Bay and central Delta region) in August 2002, to 86 NTU at site D41 in September 2002.

Turbidity levels at some sites exhibited a seasonal pattern of high turbidity in the early spring, followed by decreasing turbidity through summer and fall. However, some sites showed no consistent seasonal pattern.

A large increase in turbidity was observed at most sites in January 2002. A similar increase occurred in March 2001; however, this increase was not observed at all sites. These pulses of turbidity appear to coincide with marked decreases in specific conductance, which suggests that increased runoff could be causing increased turbidity from resuspension of sediment, or overland contaminants.

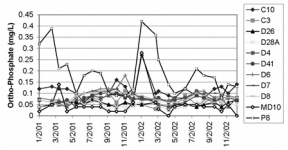

Figure 3-12 Bay-Delta orthophosphate, 2001-2002

Orthophosphate

Orthophosphate is soluble inorganic phosphate, the phosphorus compound most immediately available for assimilation by phytoplankton. Orthophosphate concentrations were measured by first collecting sample aliquots from a 1-meter depth into new, rinsed polyethylene bottles. The samples were then filtered through a pre-washed membrane filter with a 0.45-micron pore size. The filtrate was immediately frozen and later transported to Bryte Laboratory[2] for analysis according to the USEPA (1983) colormetric automated ascorbic acid method 365.1. The minimum reporting limit for orthophosphate was 0.01 mg /L.

Values for orthophosphate varied considerably between sites and across seasons (Figures 3-12 and 3-13). The lowest values were recorded in the east Delta at site MD10 in April and December 2002, in which orthophosphate levels were below the detectable limit of 0.01 mg/L. The highest value of orthophosphate, 0.42 mg/L, was recorded at site P8 in January 2002.

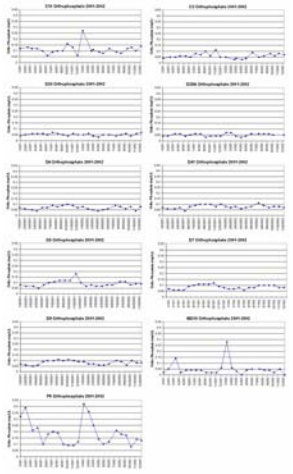

Figure 3-13 Orthophosphate concentrations at specific Bay-Delta sampling sites, 2001-2002

Total Phosphorus

Total phosphorus is the sum of all phosphorous compounds in the sample. This parameter includes phosphorous compounds that are bioavailable, as well as those that are not. Phosphorous that is unavailable for bioassimilation includes phosphorous compounds incorporated into biological tissue, as well as insoluble mineral particles.

Total phosphorous concentrations were measured by first collecting sample aliquots from a 1-meter depth into new, rinsed polyethylene bottles. The samples were then filtered through a pre-washed membrane filter with a 0.45-micron pore size. The filtrate was immediately frozen and later transported to Bryte Laboratory for analysis according to the USEPA (1983) colormetric semi-automated method 365.4. The minimum reporting limit for total phosphorous was 0.01 mg/L.

Values for total phosphate varied considerably between sites and across seasons (Figures 3-14 and 3-15). The lowest value of 0.04 mg/L was recorded in the east Delta at site MD10 in January 2001. The highest values for total phosphate were recorded in the south Delta at sites P8 and C10. Maximum values of 0.5 mg/L were recorded at these sites in January 2001 and 2002, as well as in February 2001.

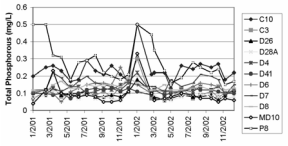

Figure 3-14 Bay-Delta phosphorous, 2001-2002

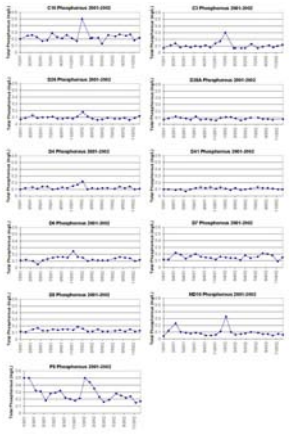

Figure 3-15 Total phosphorous concentrations in the Bay-Delta, 2001-2002

[2] Bryte Chemical Laboratory, Department of Water Resources, 1450 Riverbank Road, West Sacramento, CA 95605

Most sites showed total phosphorous levels averaging about 0.1 mg/L. A pulse increase in total phosphorous was seen at half of the sampling sites during winter 2002. Sites P8 and C10 in the south Delta had the highest degree of variability, with P8 showing a pronounced winter increase in concentrations; however, no clear pattern of interannual variation was seen in these data.

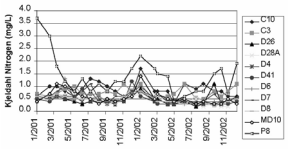

Figure 3-16 Bay-Delta Kjeldahl nitrogen, 2001–2002

Kjeldahl Nitrogen

Kjeldahl nitrogen is nitrogen in the form of organic proteins or their decomposition product, ammonia, as measured by the Kjeldahl method (APHA 1992).

Kjeldahl nitrogen concentrations were measured by first collecting sample aliquots from a 1-meter depth into new, rinsed polyethylene bottles. The samples were then filtered through a pre-washed membrane filter with a 0.45-micron pore size. The filtrate was immediately frozen and later transported to Bryte Laboratory for analysis according to the USEPA (1983) colormetric semi-automated method 352.1. The minimum reporting limit for Kjeldahl nitrogen is 0.01 mg /L.

Kjeldahl nitrogen concentrations ranged from 3.70 mg/L at station P8 in the south Delta in January 2001, to 0.20 mg/L at stations D26, D28A, and D8 from July to October 2002 (Figures 3-16 and 3-17). Aside from a pronounced seasonal change in concentrations at site P8, no strong seasonal or interannual trends were apparent, although sites showed winter increases in January and December 2002. However, this winter increase was not seen in 2001.

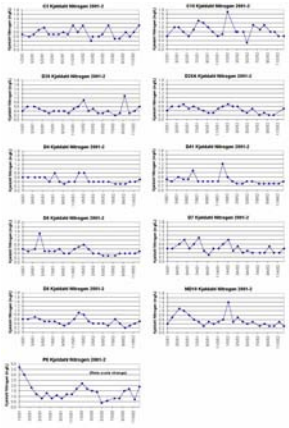

Figure 3-17 Kjeldahl nitrogen concentrations in the Bay-Delta, 2001-2002

Site P8 had both the highest concentrations, as well as the greatest variability. Average values of Kjeldahl nitrogen in all sampled sites, excluding P8, was 0.57 mg/L.

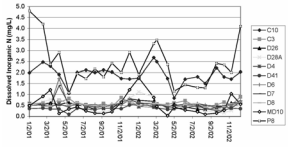

Figure 3-18 Bay-Delta dissolved inorganic nitrogen, 2001–2002

Dissolved Inorganic Nitrogen

Dissolved inorganic nitrogen (DIN) is a measure of total ammonia (NH_3), nitrate (NO_3), and nitrite (NO_2), the nitrogen forms immediately available for assimilation by phytoplankton. DIN was measured by first pumping water samples from a 1-meter depth into new, rinsed polyethylene bottles. The samples were then filtered through a pre-washed membrane filter with a 0.45-micron pore size. The filtrate was immediately frozen and later transported to Bryte Laboratory for analysis for total ammonia according to the USEPA (1983) colormetric, automated, phenate method 350.1; and for nitrate and nitrite according to the colormetric automated cadmium reduction method 353.2 (USEPA 1983).The minimum reporting limit for inorganic nitrogen was 0.01 mg /L.

DIN concentrations ranged from 0.14 mg/L at station MD10 in the east Delta in September 2001, to 4.8 mg/L at station P8 in the south Delta in January 2002 (Figures 3-18 and 3-19). These minima and maxima, and their locations, correspond closely to the results observed in 1997-2000 (Gehrts et al. 2003).

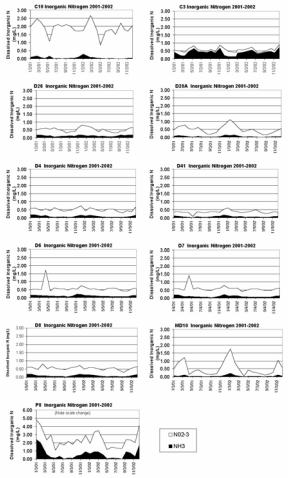

Figure 3-19 Dissolved inorganic nitrogen concentrations in the Bay-Delta, 2001–2002

Peak DIN concentrations were observed in winter 2001 (December and January), a period when seasonal runoff is high at several sites, including MD10, D4, D41, D28A, D26, and C10. Concentrations in these regions generally were lowest in August and September, when water temperatures and phytoplankton growth were highest and inflows were lowest. Concentrations in the south Delta showed the greatest degree of variability, both seasonally and interannually. By contrast, DIN concentrations in the Suisun Bay (D6, D7, and D8) varied little on a seasonal or interannual basis, except for a sharp peak in the DIN concentrations in April 2001.

Dissolved Organic Nitrogen

Organic nitrogen is defined functionally as nitrogen that is bound to carbon containing compounds in the tri-negative oxidation state (APHA 1992). This form of nitrogen must be mineralized or decomposed before it can be used by the plant communities in aquatic and terrestrial environments. It does not include all organic nitrogen compounds, but does include proteins, peptides, nucleic acids, urea, and numerous synthetic organic compounds (APHA 1992).

Dissolved organic nitrogen (DON) was measured by first pumping water samples from a 1-meter depth into new, rinsed polyethylene bottles. The samples were then filtered through a pre-washed membrane filter with a 0.45-micron pore size. The filtrate was immediately frozen and later transported to Bryte Laboratory for analysis according to the USEPA (1983) colormetric, semi-automated method 351.2. The minimum reporting limit for DON was 0.10 mg /L.

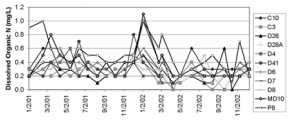

Figure 3-20 Bay-Delta dissolved organic nitrogen, 2001–2002

DON concentrations ranged from 1.10 mg/L at station MD10 in the east Delta in January 2002, to concentrations that fell below undetectable levels (i.e., < 0.10 mg/L) at several stations (C10, C3, D26, D4, D41, D6, and D8) in 2002 (Figures 3-20 and 3-21). DON concentrations showed no clear seasonal or interannual pattern of variation; however, a general increase in DON concentrations was seen at most sites in December 2001 and January 2002. This increase generally corresponds to the increase in Kjeldahl nitrogen concentrations observed during the same period. These data also show that DON concentrations decreased somewhat from 2001 to 2002, as evidenced by the large number of sites with undetectable concentrations in 2002.

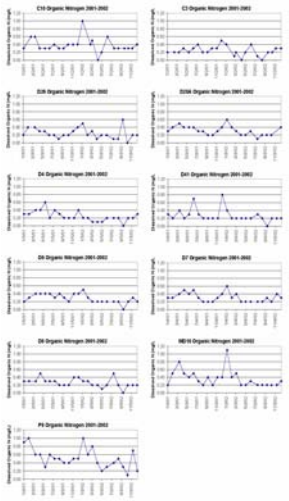

Figure 3-21 Dissolved organic nitrogen concentrations in the Bay-Delta, 2001–2002

Total Dissolved Solids

Dissolved solids analysis is a measure of the solid fraction of a sample able to pass through a filter. The measurement of dissolved solids gives a general indication of the suitability of the water as a drinking source and for certain agricultural and industrial uses. As a drinking source, waters with high dissolved solids are of inferior palatability and may induce an unfavorable physiological reaction in consumers (APHA 1992).

Total dissolved solids (TDS) were measured by first pumping water samples from a 1-meter depth into new, rinsed polyethylene bottles. The samples

were then filtered through a pre-washed 0.45-micron pore size membrane filter. The filtrate was frozen immediately and later transported to Bryte Laboratory for analysis, using EPA (1983) method 160.1.

TDS in the Bay-Delta varied over a wide range from 30,780 mg/L in January 2001 at site D41 in the San Pablo Bay, to 82 mg/L in April 2001 at site C3 in the north Delta (Figures 3-22 and 3-23). The high values seen in San Pablo Bay are likely due to tidal influences of seawater with high TDS entering the Delta at San Pablo Bay. Low TDS values seen at site C3 are likely due to spring inflows of fresh water, with lower TDS concentrations from the Sacramento River.

All sites subject to significant tidal exchange (sites D41, D6, D7, D8, and D4) show TDS concentrations in proportion to their proximity to the coast (Figure 3-1).

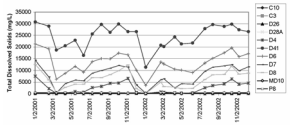

Figure 3-22 Bay-Delta total dissolved solids, 2001–2002

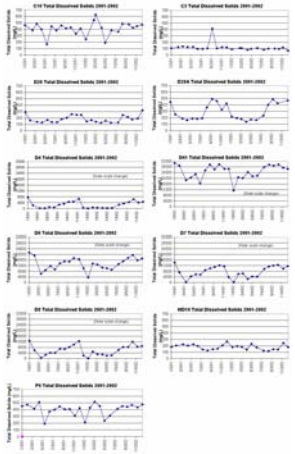

Figure 3-23 Total dissolved solids in the Bay-Delta, 2001–2002

Total Suspended Solids

Suspended solids are the solids present in a water sample retained on a filter after the sample is filtered. Suspended solids include a wide variety of material such as silt, living or decaying organic matter, and anthropogenic matter. High amounts of suspended solids block light penetration into the water column and increase heat absorption.

Total suspended solids (TSS) may increase in surface waters in response to higher flow rates, as higher velocities increase water's capacity to hold or carry suspended solids. Runoff from heavy rains can simultaneously introduce large amounts of solids into surface waters and provide the capacity for their suspension. Therefore, suspended solids concentrations can vary significantly over relatively short time periods.

Water samples for TSS analysis were taken from aliquots collected from a depth of 1 meter, stored in polyethylene bottles and refrigerated at 4 °C until analyzed at Bryte Laboratory using USEPA (1983) method 160.2.

TSS in the San Francisco Bay-Delta varied over a wide range from 118 mg/L in January 2001 at site C3 in the north Delta, to values below the reporting limit of 1 mg/L at several sites in both 2001 and 2002 (Figures 3-24 and 3-25). Several sites showed "pulse" increases in TSS that occurred during winter months. For example, TSS levels at site C3 increased from 8 mg/L to 118 mg/L from November 2001 to January 2002, and returned to 8 mg/L again by March 2002. Although winter pulse variations may be due to rain or hydrological events, variations in TSS at other sites occurred inter-seasonally and may reflect changing levels of organic matter.

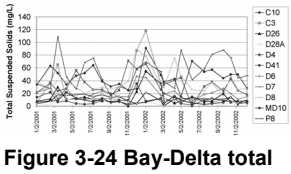

Figure 3-24 Bay-Delta total suspended solids, 2001–2002

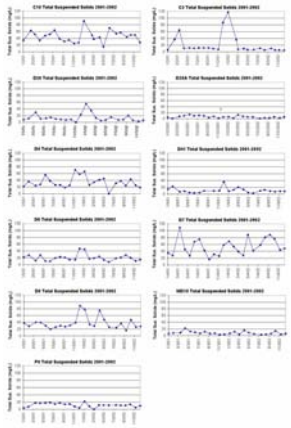

Figure 3-25 Total suspended solids in the Bay-Delta, 2001–2002

Volatile Suspended Solids

The measurement of volatile suspended solids (VSS) provides a relative indicator of the amount of organic matter present in the water sample. Water samples for VSS analysis were taken from aliquots collected from a depth of 1 meter, stored in polyethylene bottles, and refrigerated at 4 °C until analyzed at Bryte Laboratory. Samples were analyzed for VSS according to

EPA Method 160.4 (EPA 1983). The minimum reporting level for VSS in these analyses was 1.0 mg/L.

Volatile suspended solid levels occasionally fell below minimum reporting levels (<1 mg/L) in most regions from 2001 to 2002, and reached a high of 15 mg/L at site C10 in the lower Sacramento River in January 2001 (Figures 3-26 and 3-27). Sites C10 in the south Delta and C3 in the north Delta showed the highest degree of variability, with VSS levels ranging from 0 to 15 mg/L VSS. Other sites showed a narrower range of values; however, no apparent seasonal or interannual variation was seen in these data.

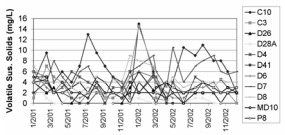

Figure 3-26 Bay-Delta volatile suspended solids, 2001–2002

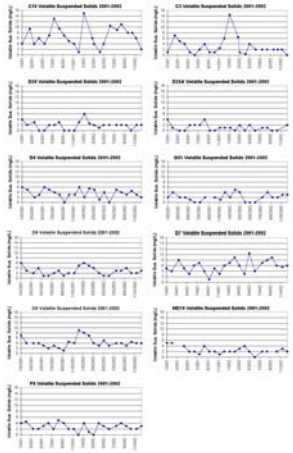

Figure 3-27 Volatile suspended solids in the Bay-Delta, 2001–2002

Silica

Water samples for silica analysis were taken from aliquots collected from a depth of 1 meter, stored in polyethylene bottles, and refrigerated at 4 °C until analyzed at Bryte Laboratory. Samples were analyzed for silica according to EPA Method 200.7 (EPA 1983). The minimum reporting level for silica in these analyses was 0.1 mg/L.

Silica concentrations ranged from 23 mg/L at site D6 in March 2002, to 2.6 mg/L at site C10 in June 2002 (Figures 3-28 and 3-29). Several sites (MD10, D28A, P8, and D26) displayed an apparent seasonal trend of declining silica levels in spring months followed by increased silica concentrations in late summer and winter. Other sites had less consistent variations, with little or no apparent seasonal correlation. No apparent interannual trends were observed in these data.

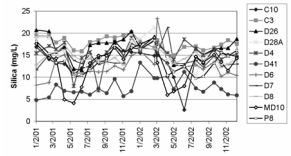

Figure 3-28 Bay-Delta silica, 2001–2002

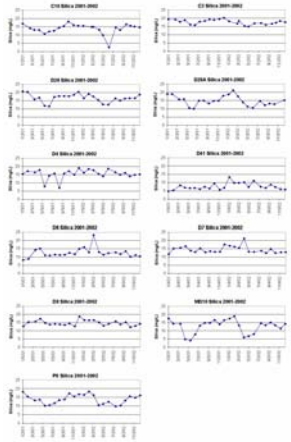

Figure 3-29 Silica concentrations in the Bay-Delta, 2001–2002

Chloride

Water samples for chloride analysis were taken from aliquots collected from a depth of 1 meter, stored in polyethylene bottles, and refrigerated at 4 °C until analyzed at Bryte Laboratory. Samples were analyzed for chloride according to EPA Method 300.0 (EPA 1983).

Chloride concentrations in the Bay-Delta varied over a wide range from 17,200 mg/L in January 2001 at site D41 in the San Pablo Bay, to 4 mg/L in July 2002 at site C3 in the north Delta (Figures 3-30 and 3-31). The high values seen in San Pablo Bay are likely due to tidal influences of seawater entering the Delta, while the low values seen at site C3 are likely due to spring flows of fresh water down the Sacramento River. Values of chloride concentrations are closely correlated to values reported for specific conductance and TDS reported earlier in this report.

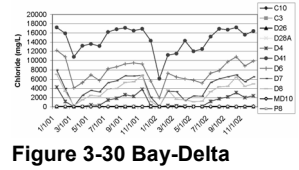

Figure 3-30 Bay-Delta chloride, 2001–2002

Summary

The Department's monitoring and reporting of water quality data shown here is mandated in order to ensure compliance with water quality objectives; identify meaningful changes potentially related to the operation of the State Water Project and the Central Valley Project; and to reveal trends in ecological changes potentially related to project operations. Flow rates, influenced by project operations and natural forces, are a primary determinant of water quality dynamics at each site described. However, flow

rates are not measured as part of this sampling protocol, and therefore a more analytical treatment of these data in relation to flow rates is not included. These data are presented as a snapshot of the system. They allow a historic comparison of a wide range of water quality parameters and show an overall consistency with recent years.

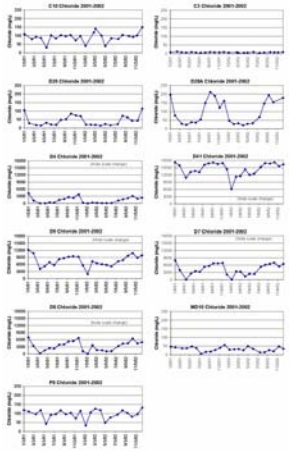

Figure 3-31 Chloride concentrations in the Bay-Delta, 2001–2002

References

Gehrts, K. A., M. Dempsey, P. Giovannini, J. Giulianotti, L. Mecum, S. Philippart, C. Ralston, K. Triboli, and S. Waller. 2003. *Water Quality Conditions in the Sacramento-San Joaquin Delta during 1997-2000*. California Department of Water Resources, Sacramento, California.

Lehman, P., S. Hayes, G. Marsh, C. Messer, C. Ralston, K. Gehrts, and J. Lee. 2001. *Water Quality Conditions in the Sacramento-San Joaquin Delta during 1996*. California Department of Water Resources, Sacramento, California.

[APHA] American Public Health Association. 1992. *Standard Methods for the Examination of Water and Wastewater*. 18th Edition, Washington DC.

[EPA] U.S. Environmental Protection Agency. 1983. *Methods for Chemical Analysis of Water and Wastes*. Technical Report EPA-600/4-79-020.

[USGS] U.S. Geological Survey. 1985. Methods for the determination of inorganic substances in water and fluvial sediments. In: *Techniques of Water Resources Investigations of USGS*.

Figure 3-1 Water quality monitoring stations

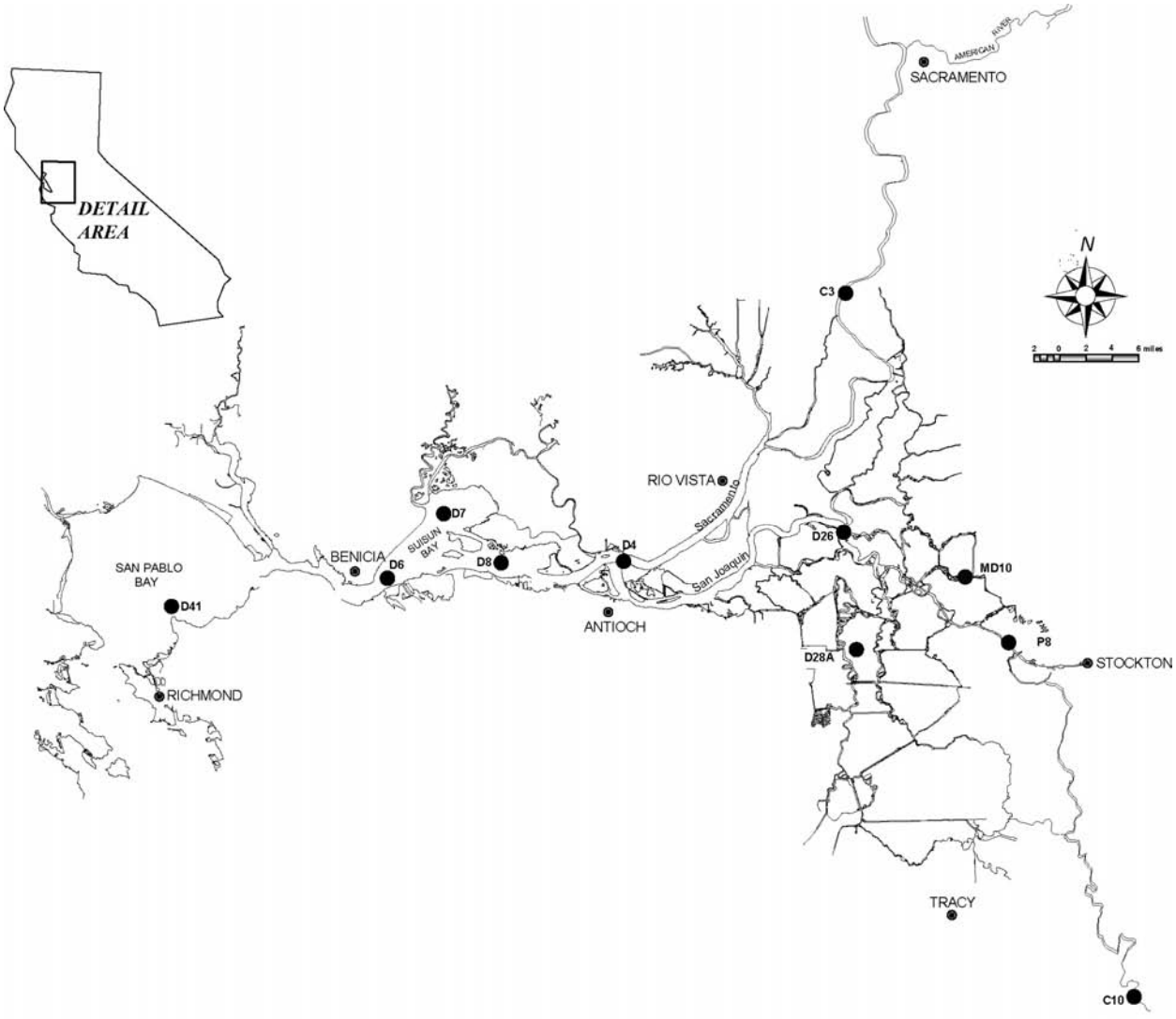

Figure 3-2 Bay-Delta temperatures—comparison of sampling sites, 2001-2002

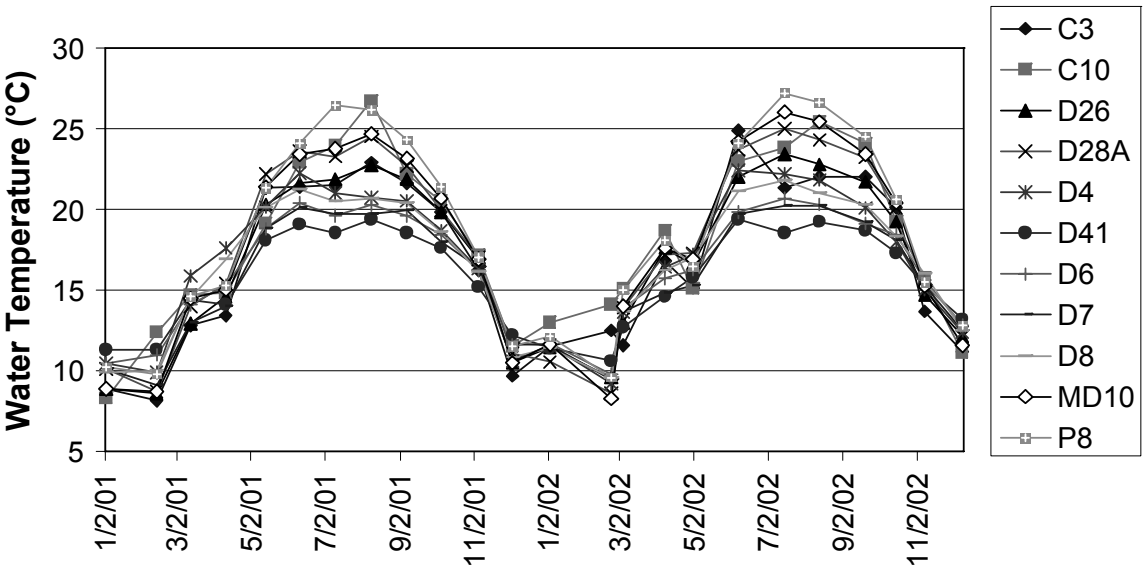

Figure 3-3 Temperatures at specific Bay-Delta sampling sites, 2001-2002

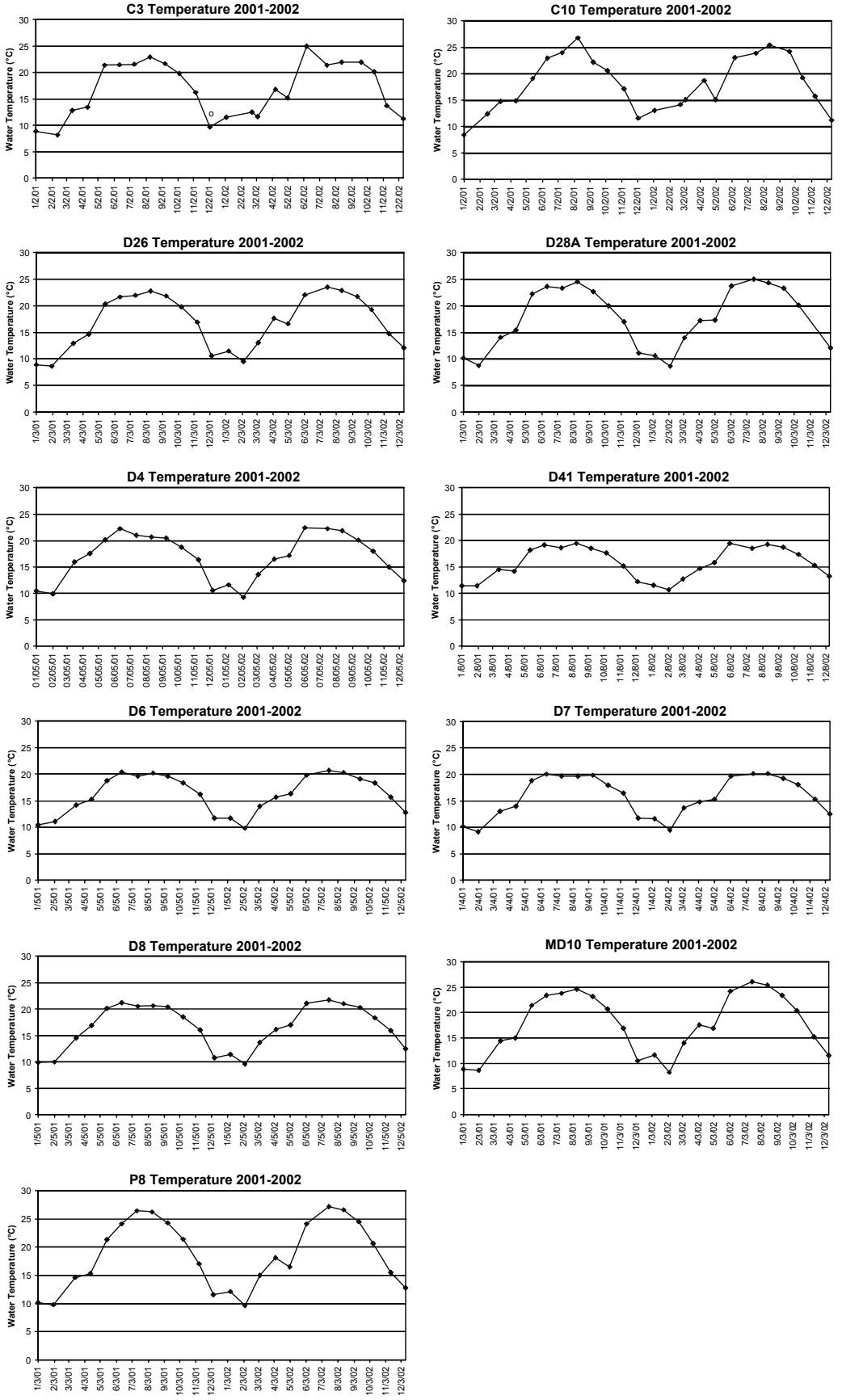

Figure 3-4 Dissolved oxygen—comparison of Bay-Delta sampling sites, 2001-2002

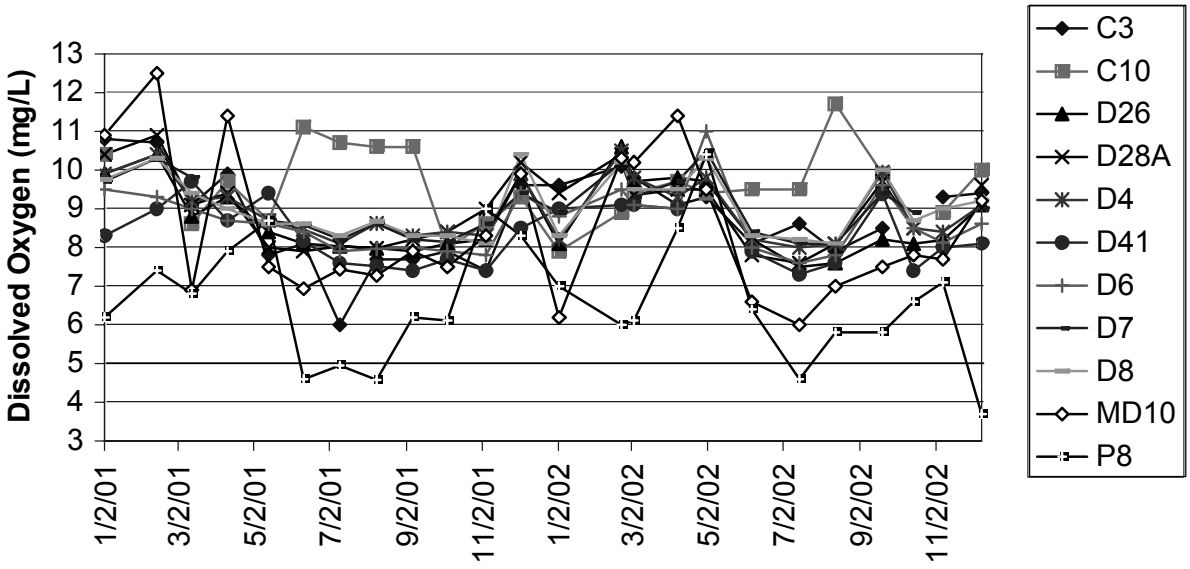

Figure 3-5 Dissolved oxygen at specific Bay-Delta sampling sites, 2001-2002

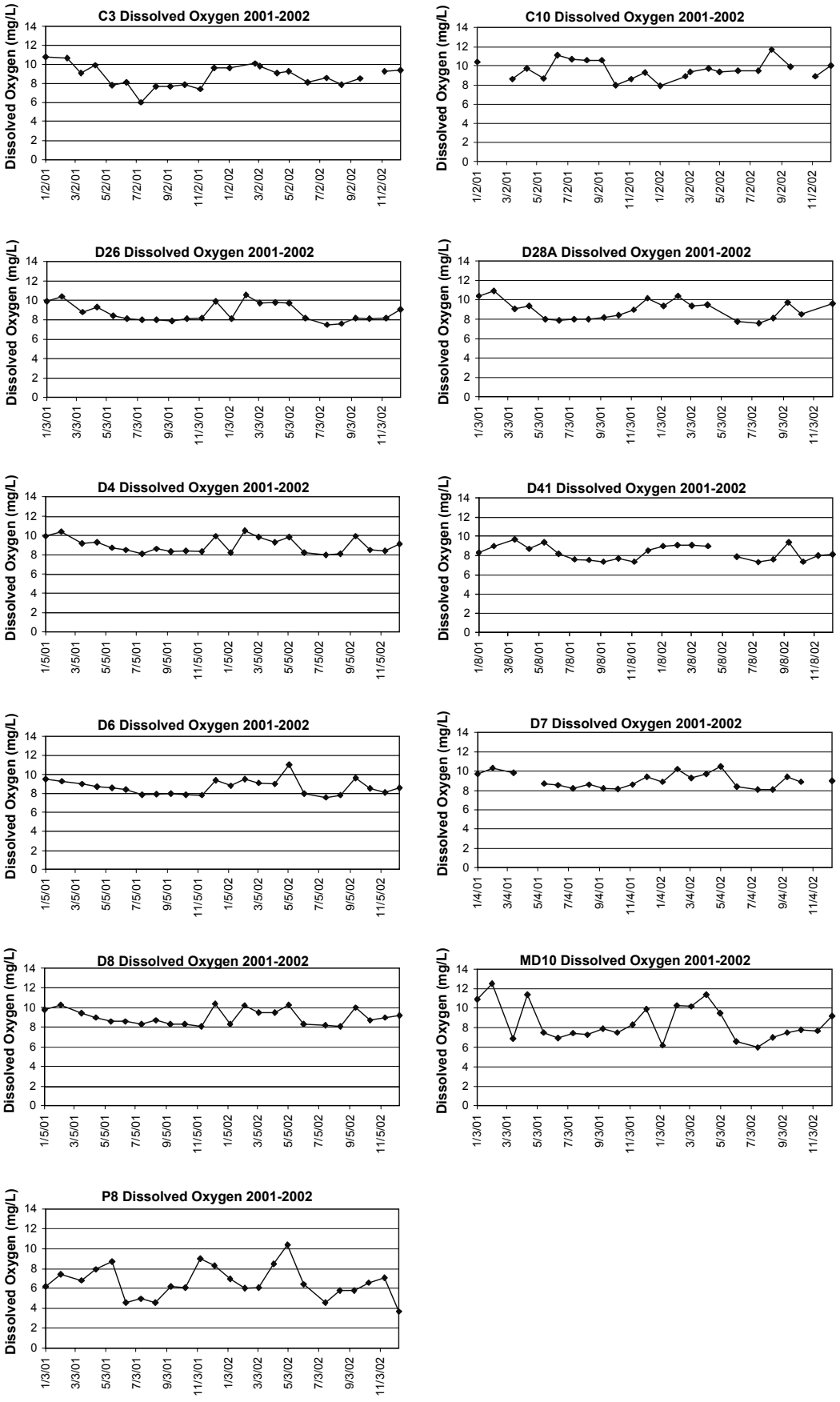

Figure 3-6 Specific conductance—comparison of Bay-Delta sampling sites, 2001-2002

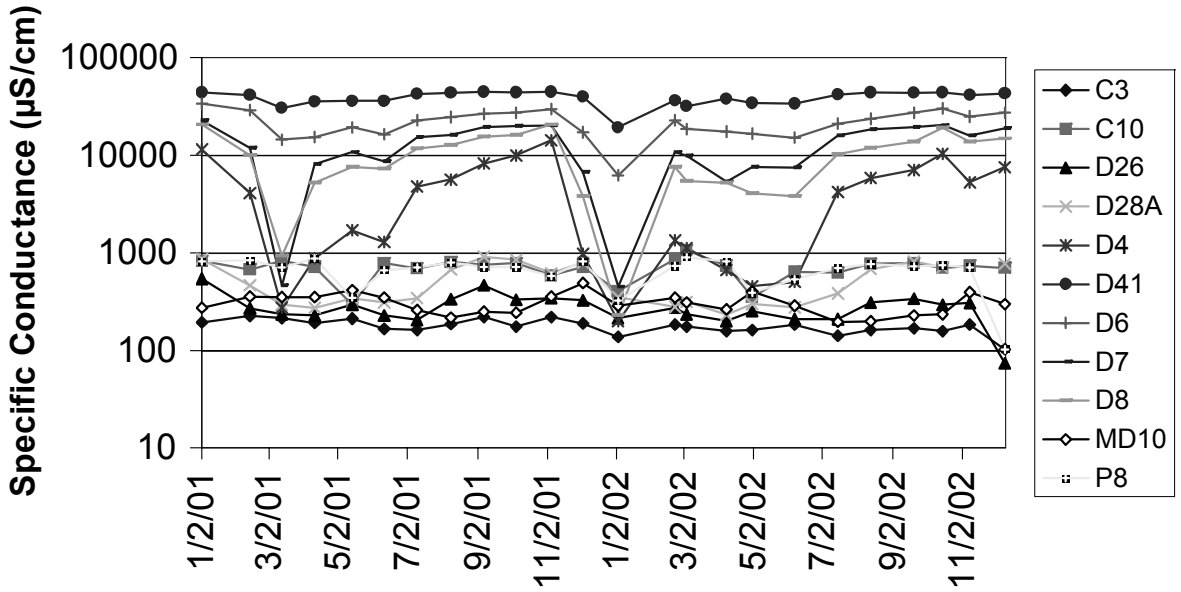

Figure 3-7 Specific conductance at specific Bay-Delta sampling sites, 2001-2002

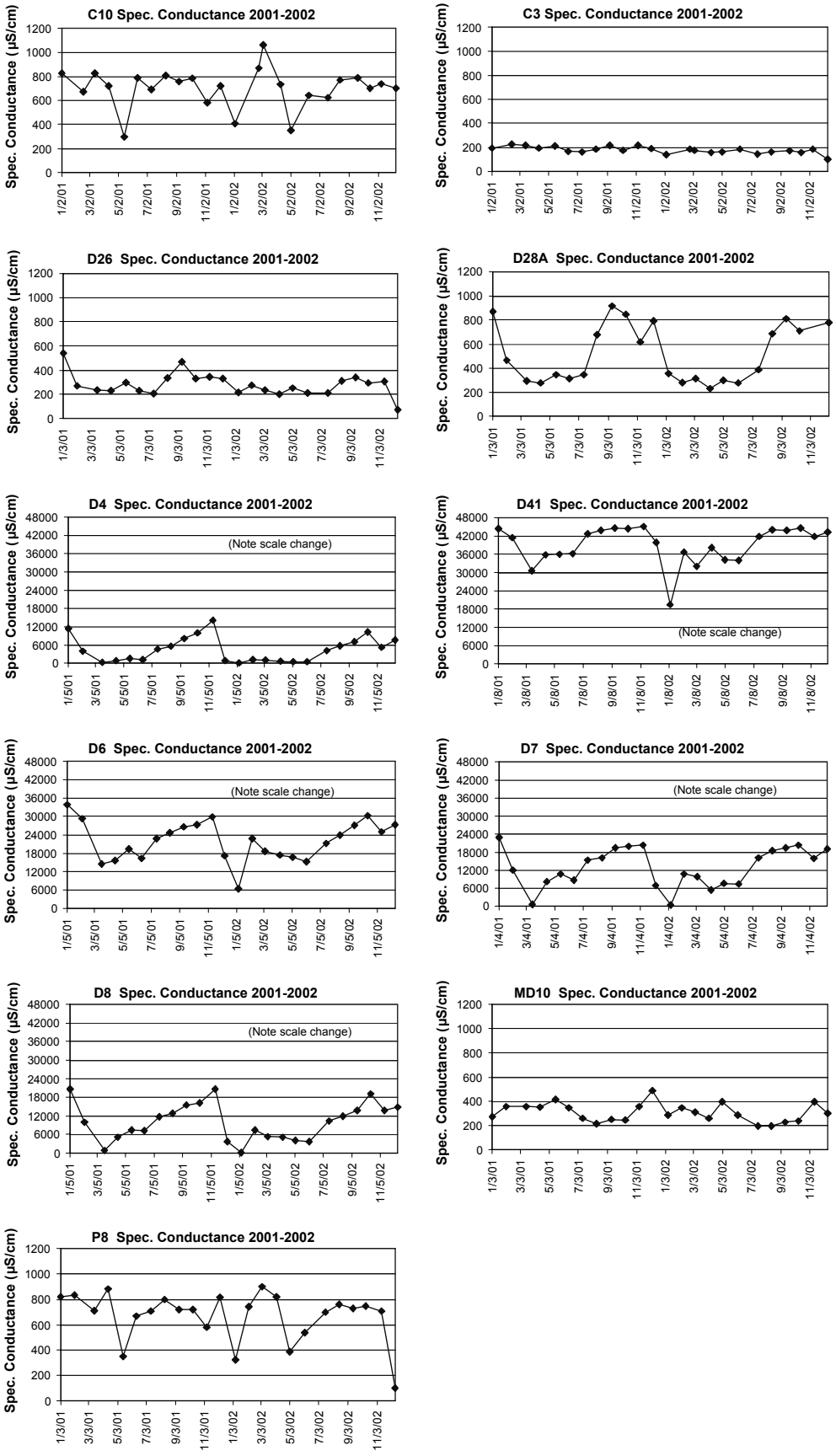

Figure 3-8 Secchi disk depth—comparison of Bay-Delta sampling sites, 2001-2002

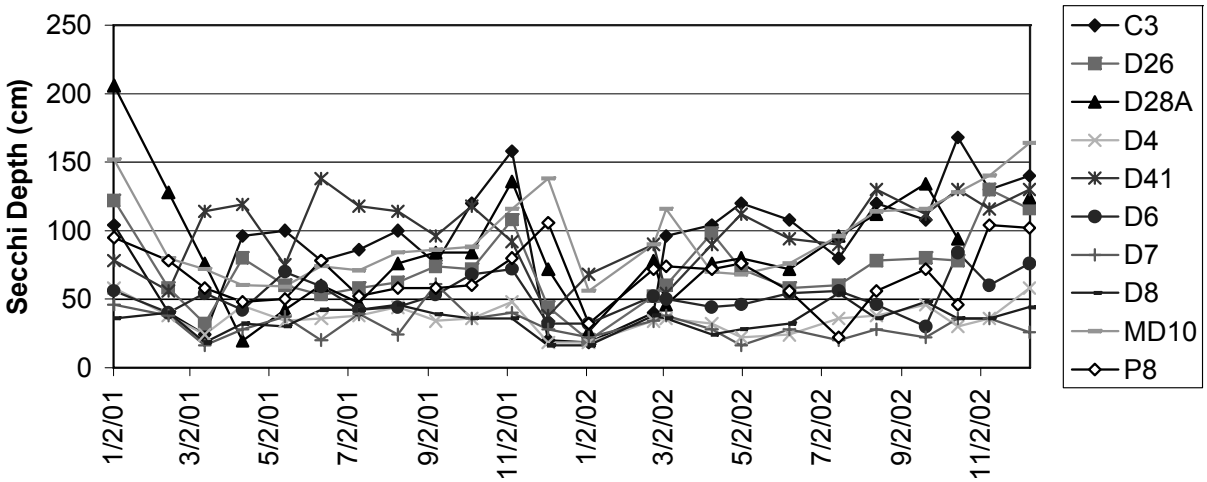

Figure 3-9 Secchi disk depth at specific Bay-Delta sampling sites, 2001-2002

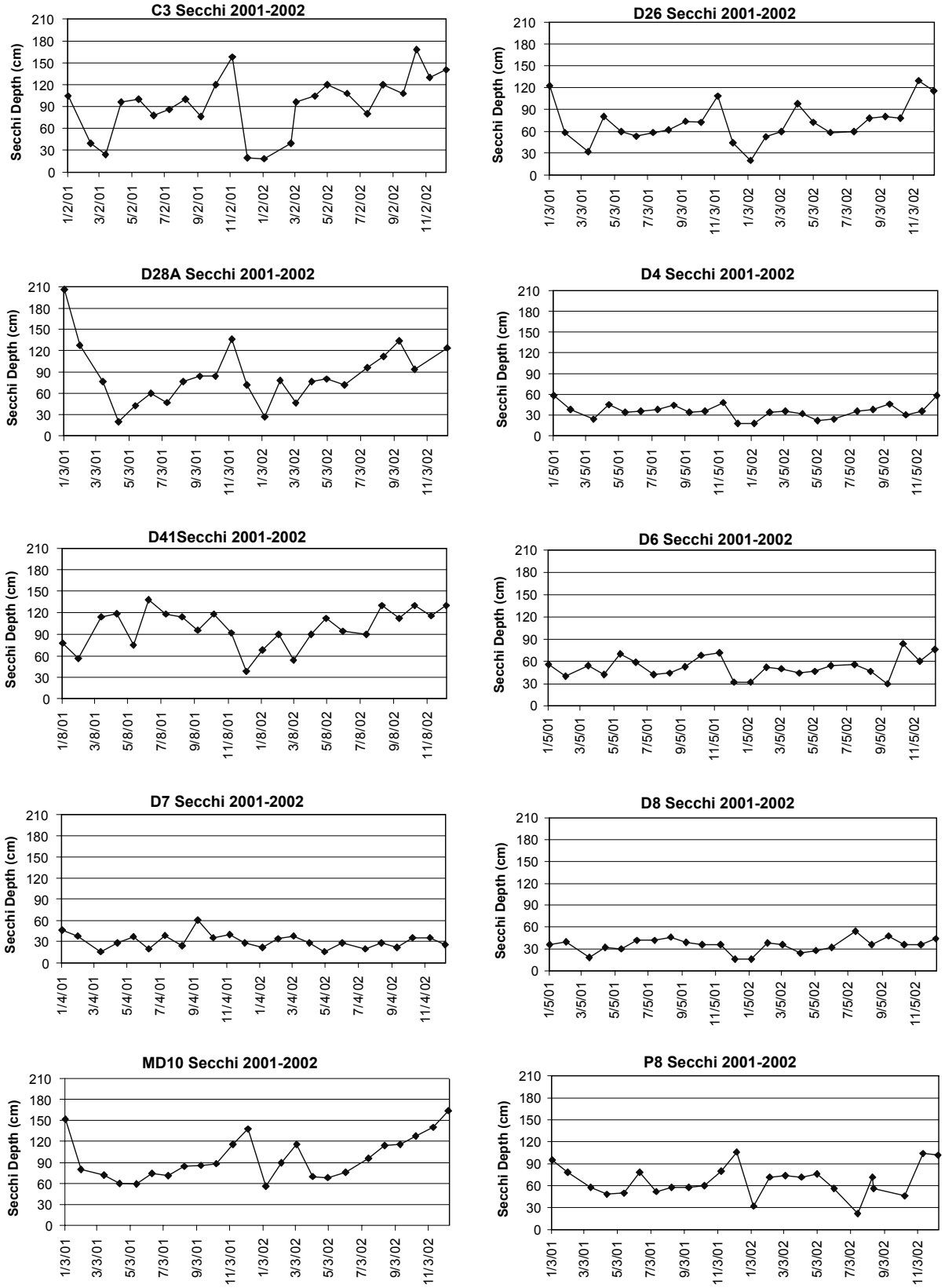

Figure 3-10 Turbidity—comparison of Bay-Delta sampling sites, 2001-2002

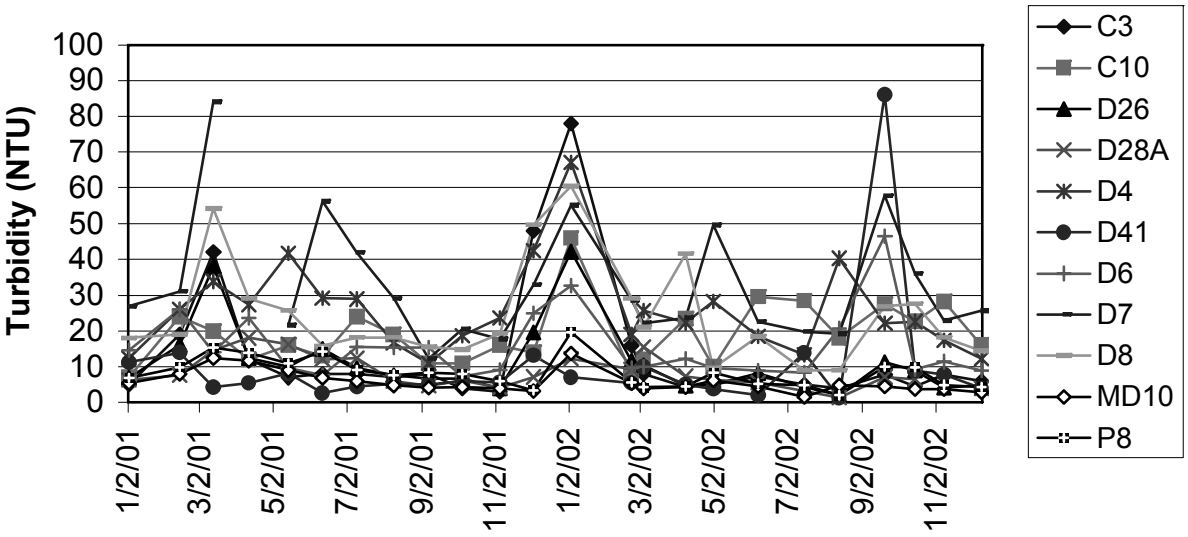

Figure 3-11 Turbidity at specific Bay-Delta sampling sites, 2001-2002

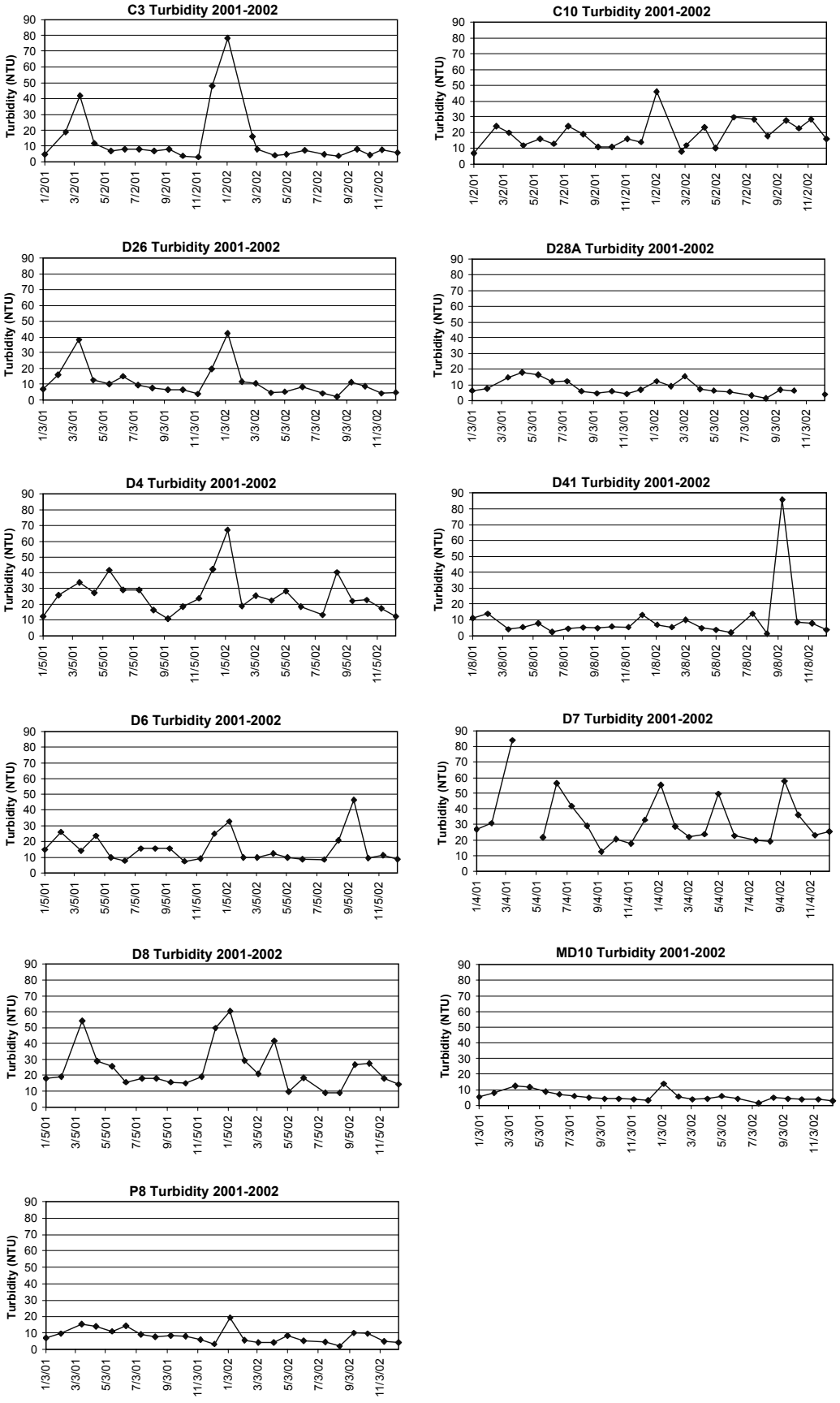

Figure 3-12 Orthophosphate concentrations—comparison of Bay-Delta sampling sites, 2001-2002

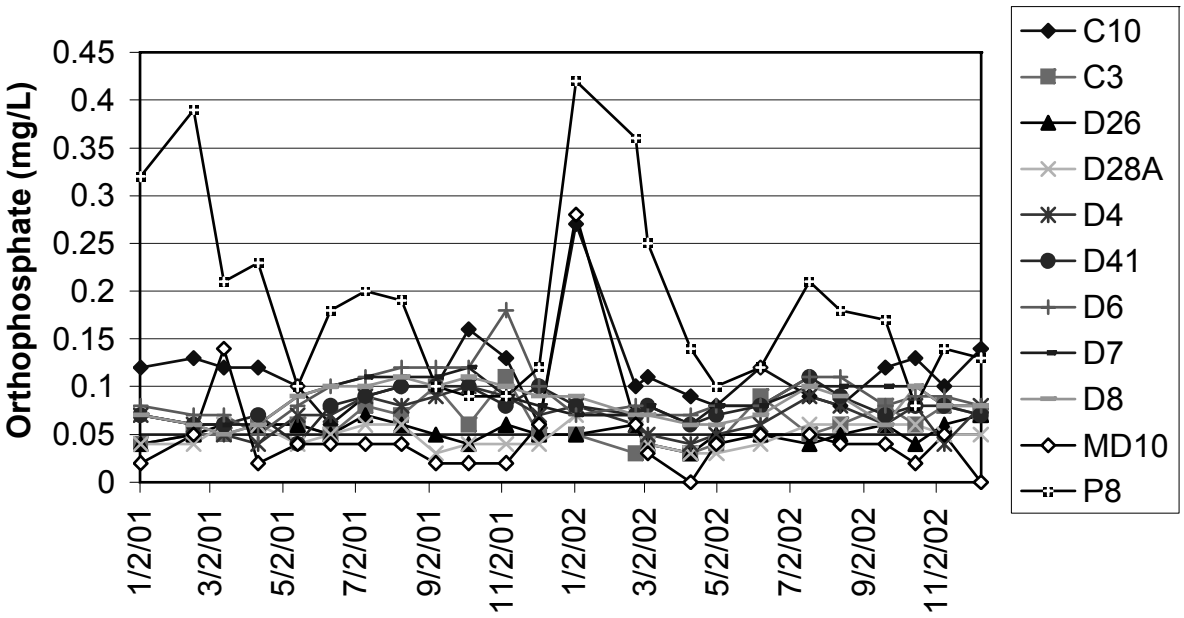

Figure 3-13 Orthophosphate concentrations at specific Bay-Delta sampling sites, 2001-2002

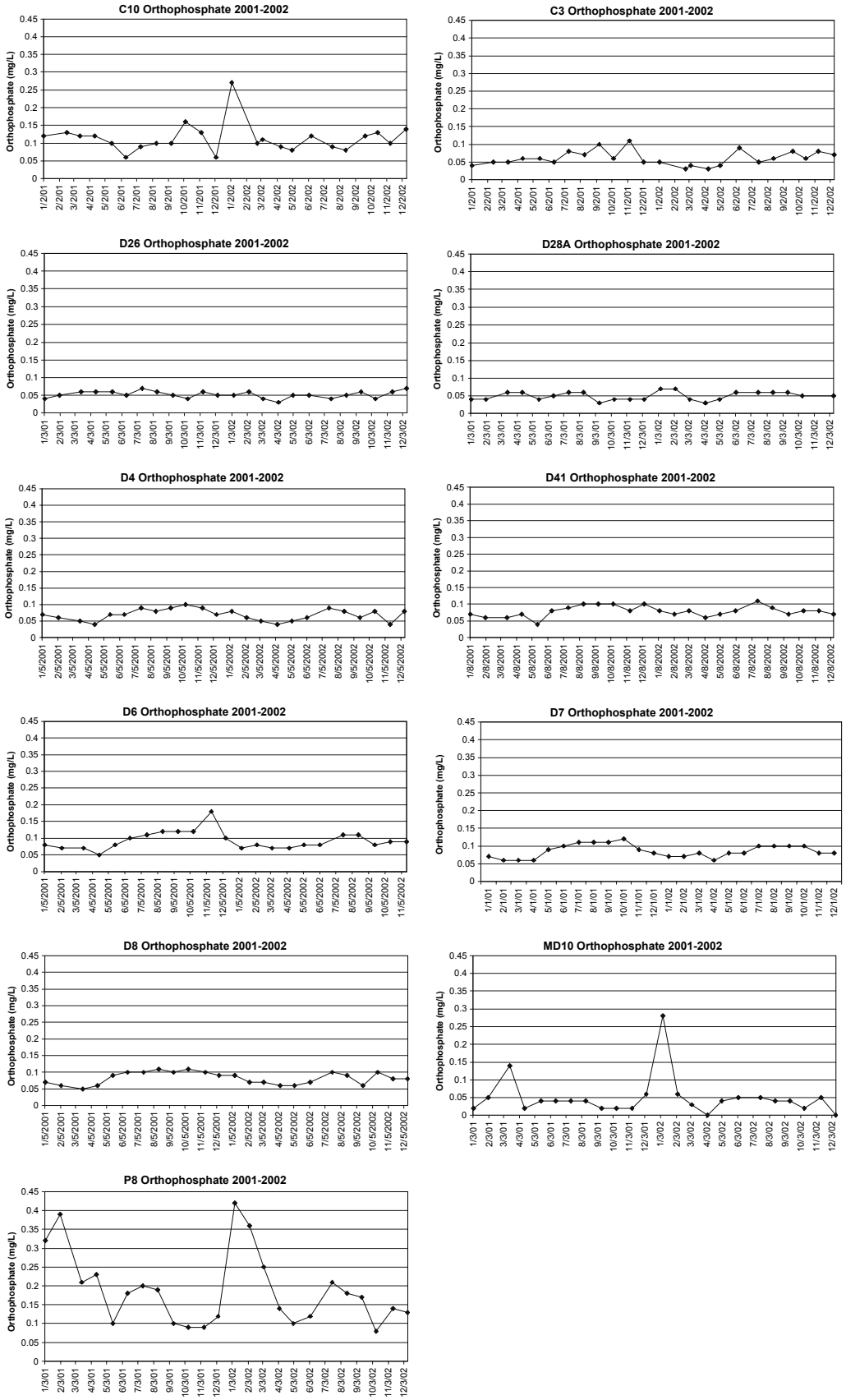

Figure 3-14 Total phosphorous concentrations—comparison of Bay-Delta sampling sites, 2001-2002

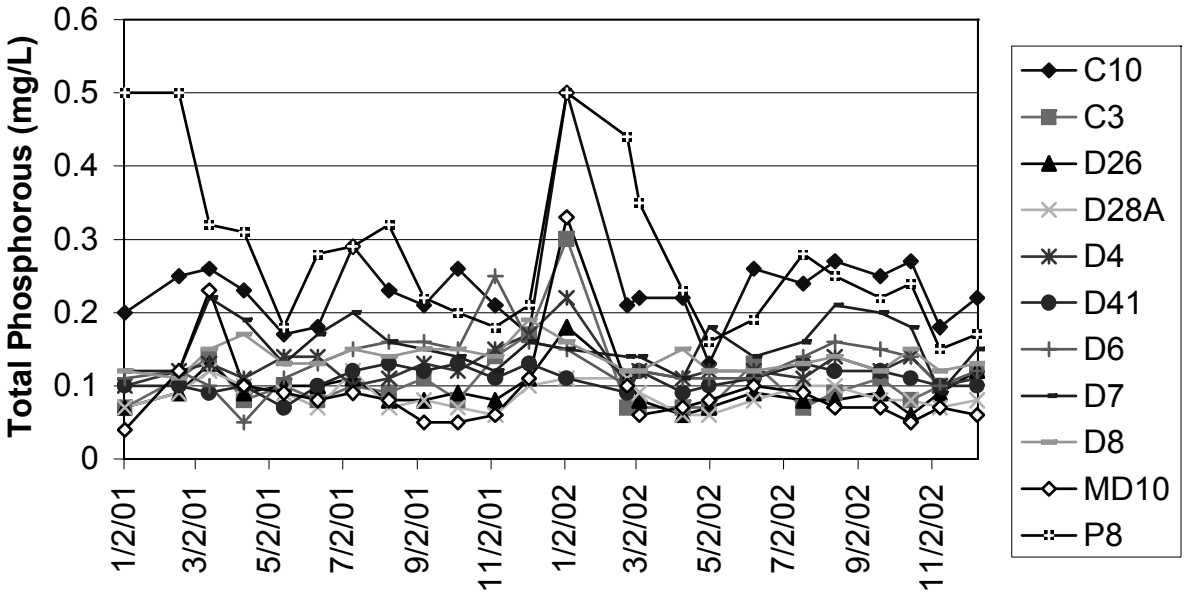

Figure 3-15 Total phosphorous concentrations at specific Bay-Delta sampling sites, 2001-2002

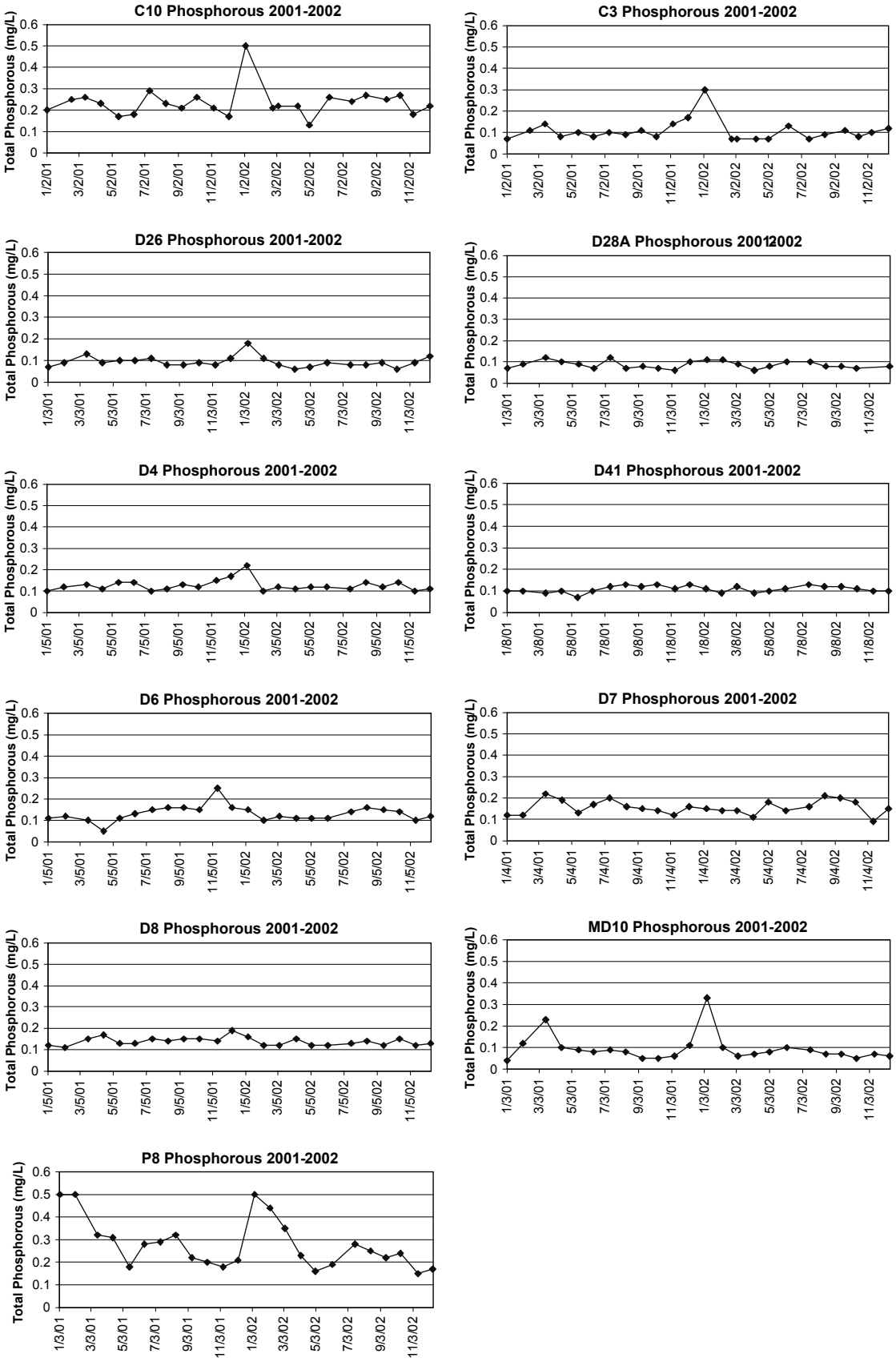

Figure 3-16 Kjeldahl nitrogen concentrations—comparison of Bay-Delta sampling sites, 2001-2002

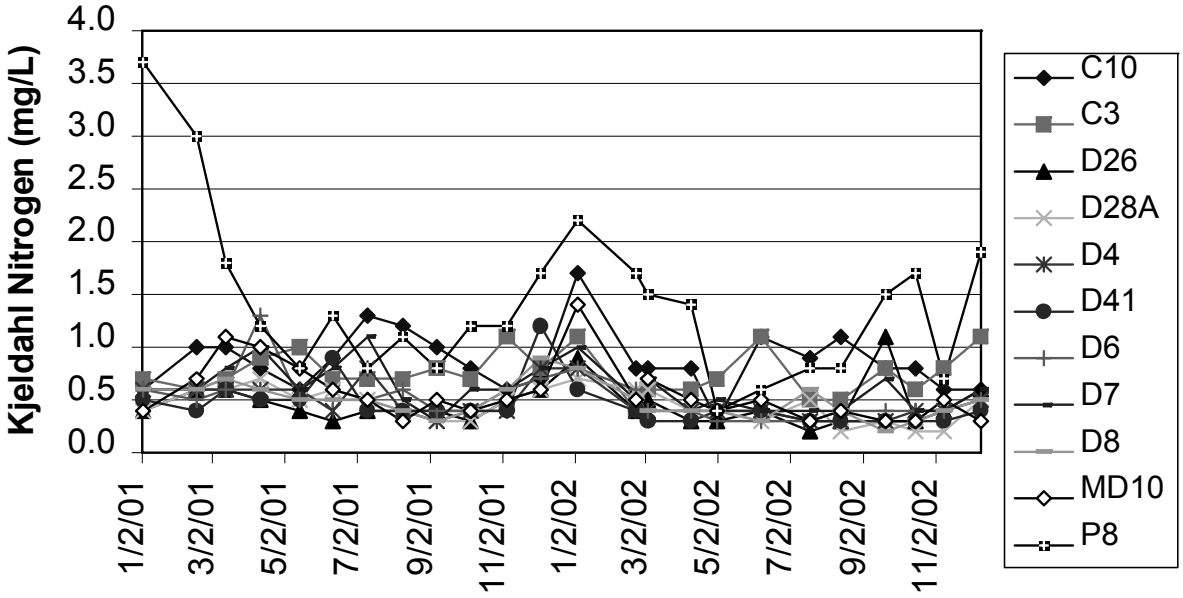

Figure 3-17 Kjeldahl nitrogen concentrations at specific Bay-Delta sampling sites, 2001-2002

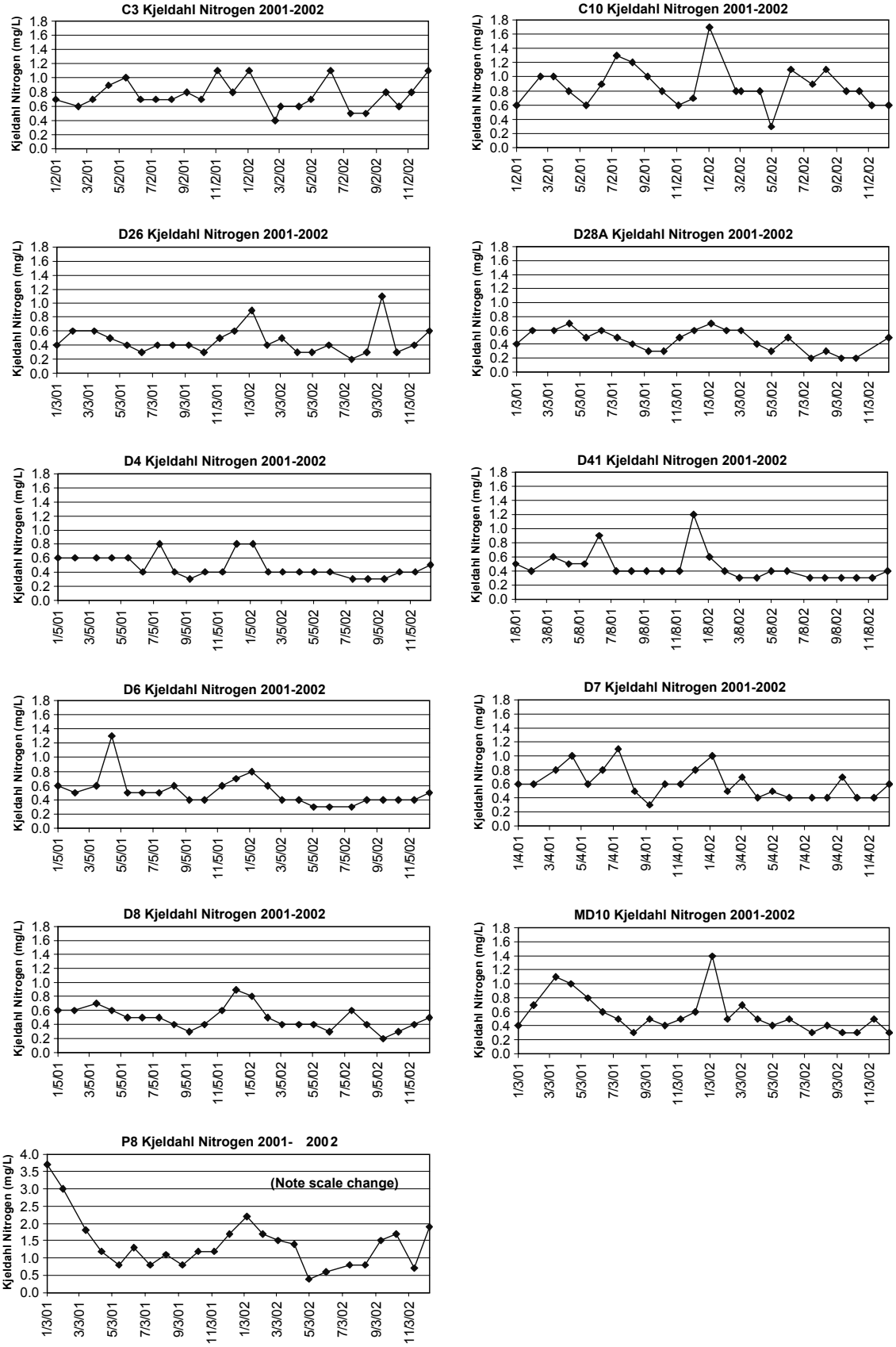

Figure 3-18 Dissolved inorganic nitrogen concentrations—comparison of Bay-Delta sampling sites, 2001-2002

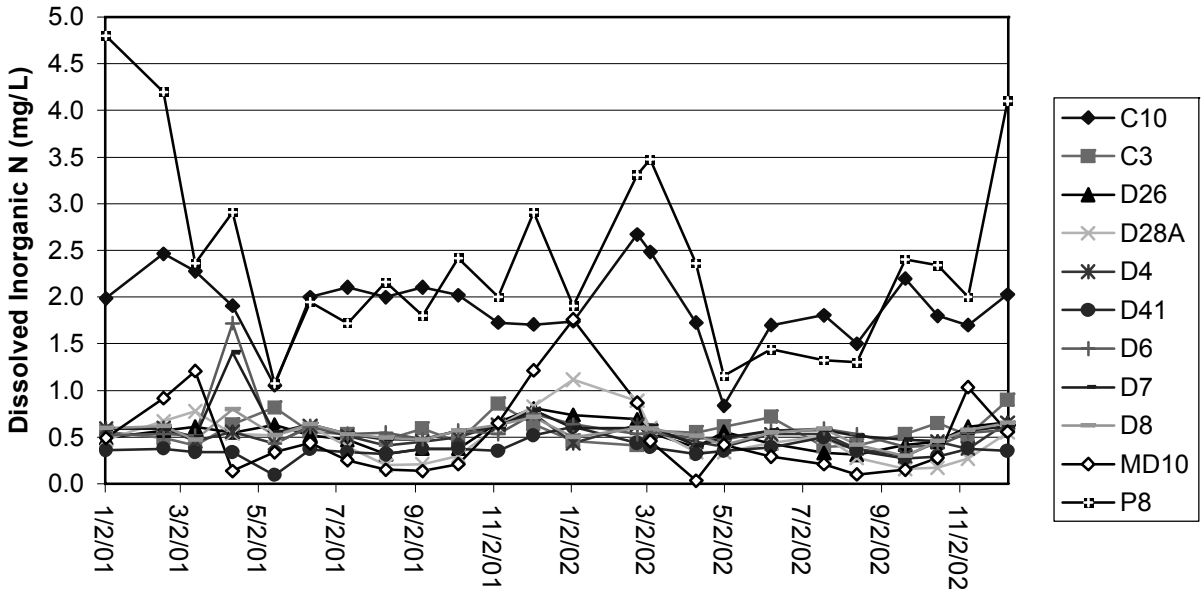

Figure 3-19 Dissolved inorganic nitrogen concentrations at specific Bay-Delta sampling sites, 2001-2002

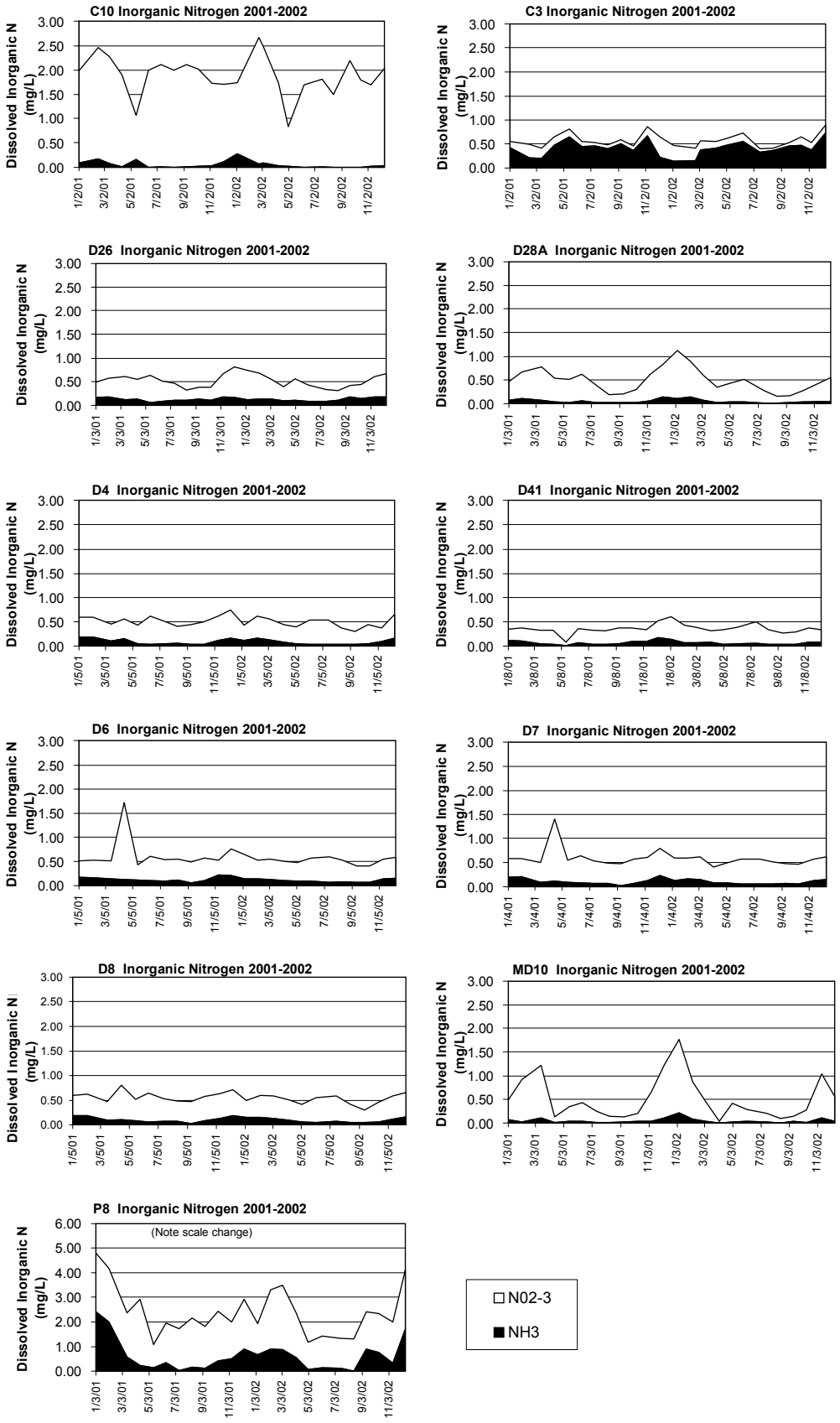

Figure 3-20 Dissolved organic nitrogen concentrations—comparison of Bay-Delta sampling sites, 2001-2002

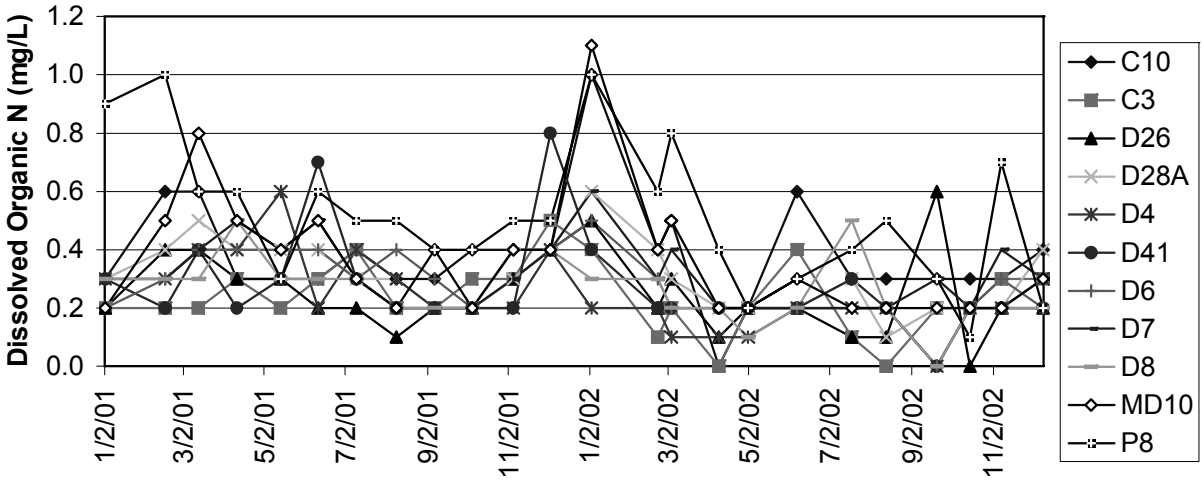

Figure 3-21 Dissolved organic nitrogen concentrations at specific Bay-Delta sampling sites, 2001-2002

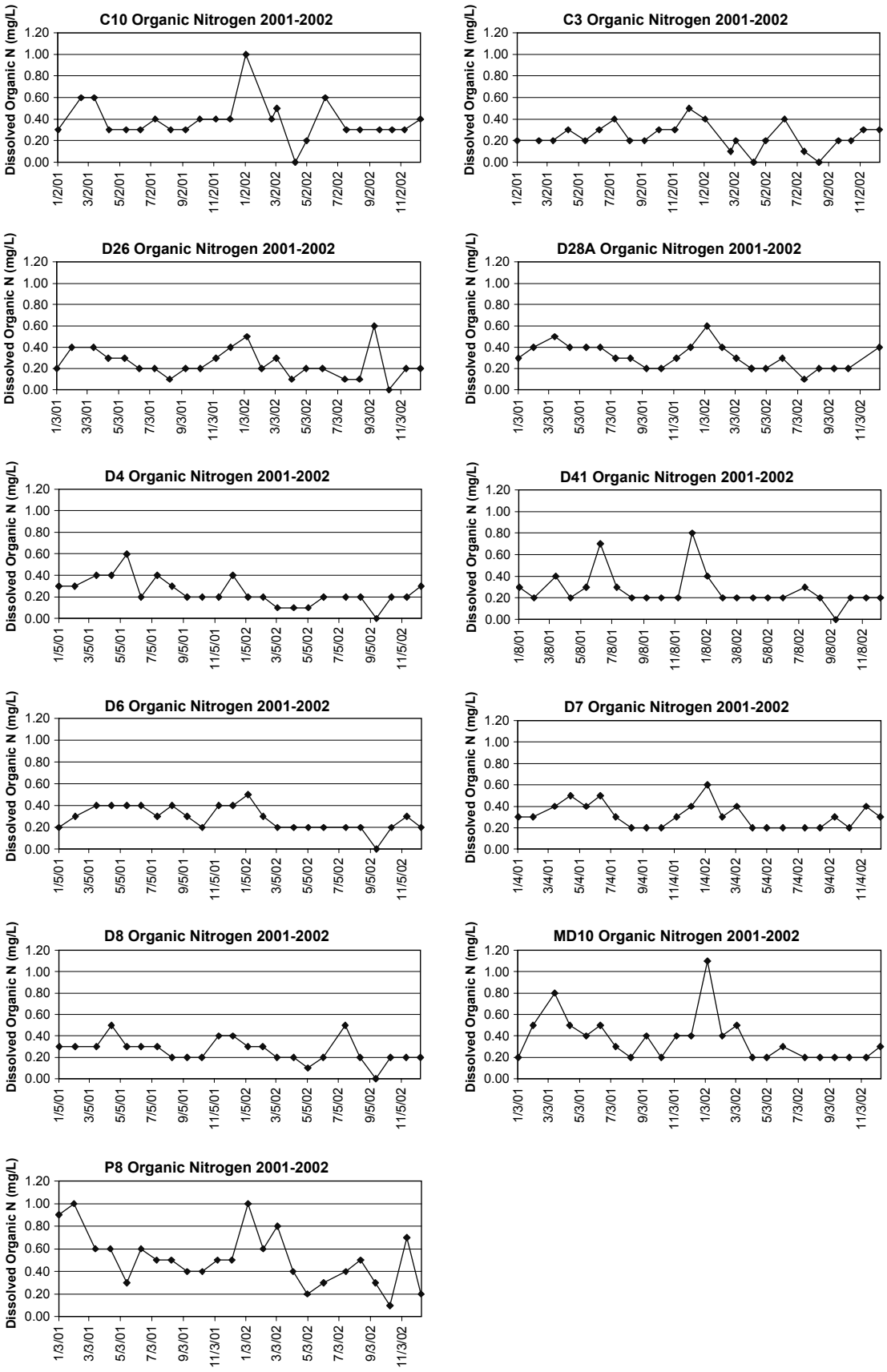

Figure 3-22 Total dissolved solids—comparison of Bay-Delta sampling sites, 2001-2002

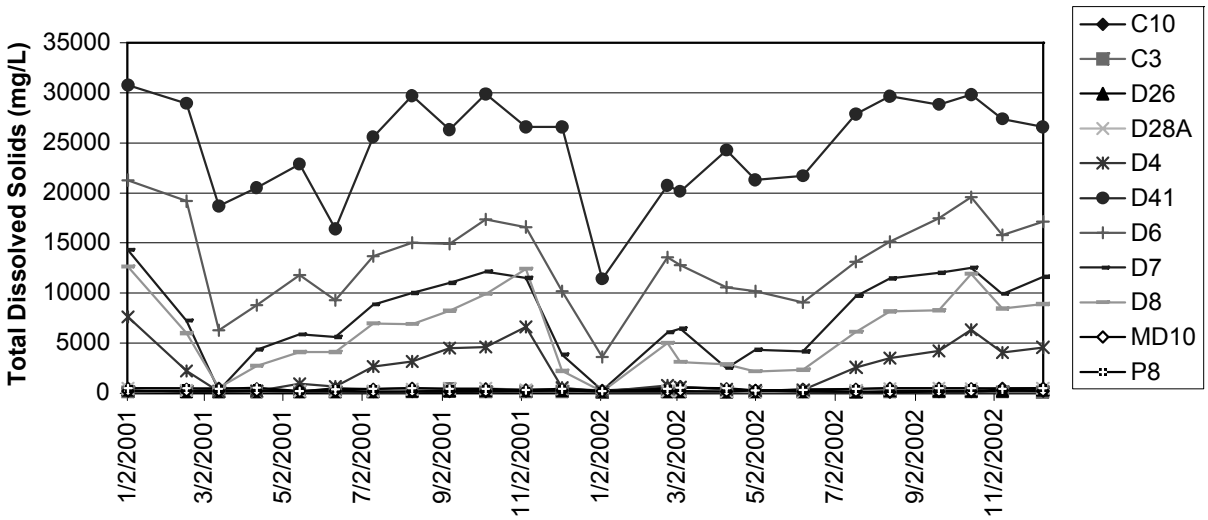

Figure 3-23 Total dissolved solids at specific Bay-Delta sampling sites, 2001-2002

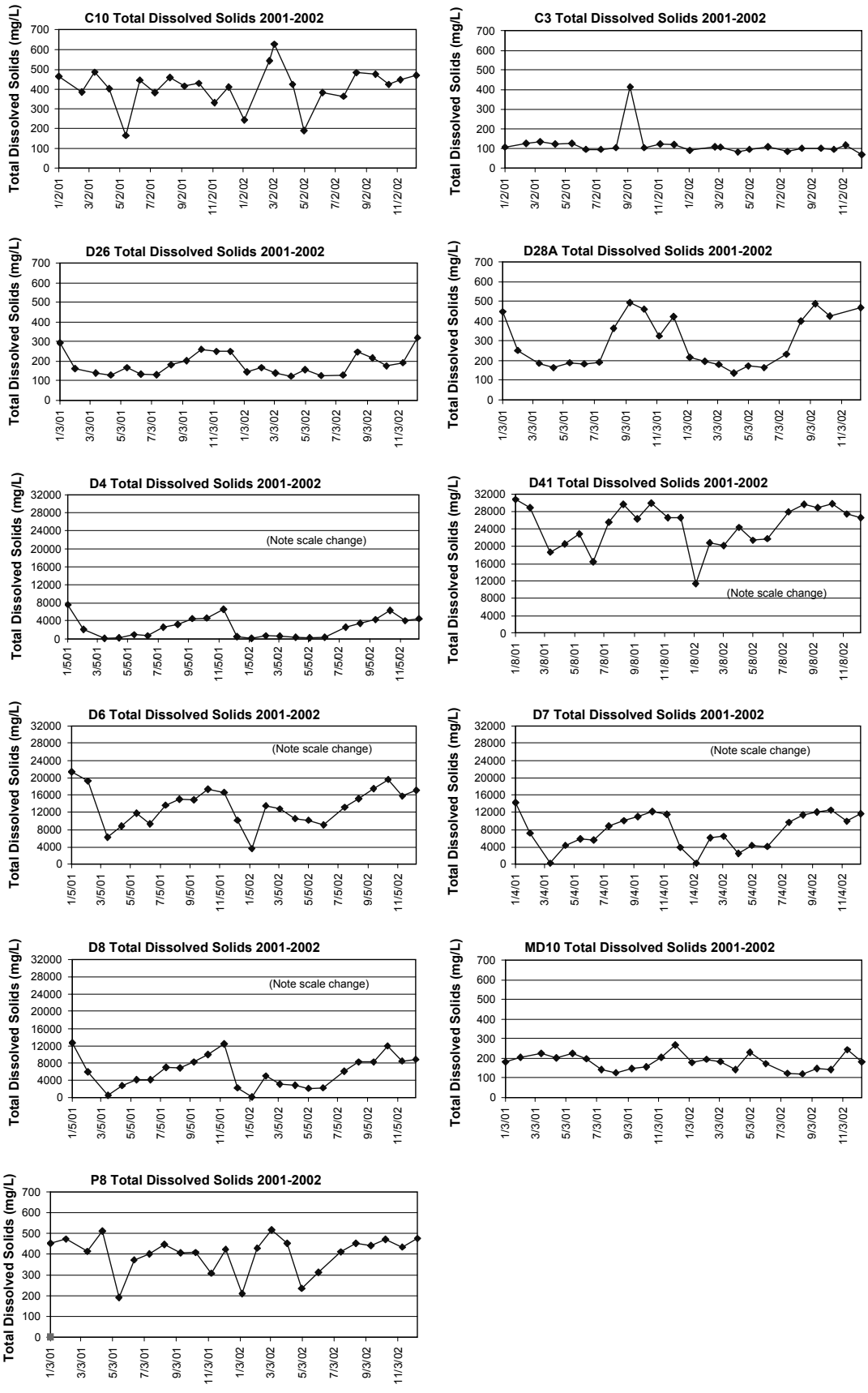

Figure 3-24 Total suspended solids—comparison of Bay-Delta sampling sites, 2001-2002

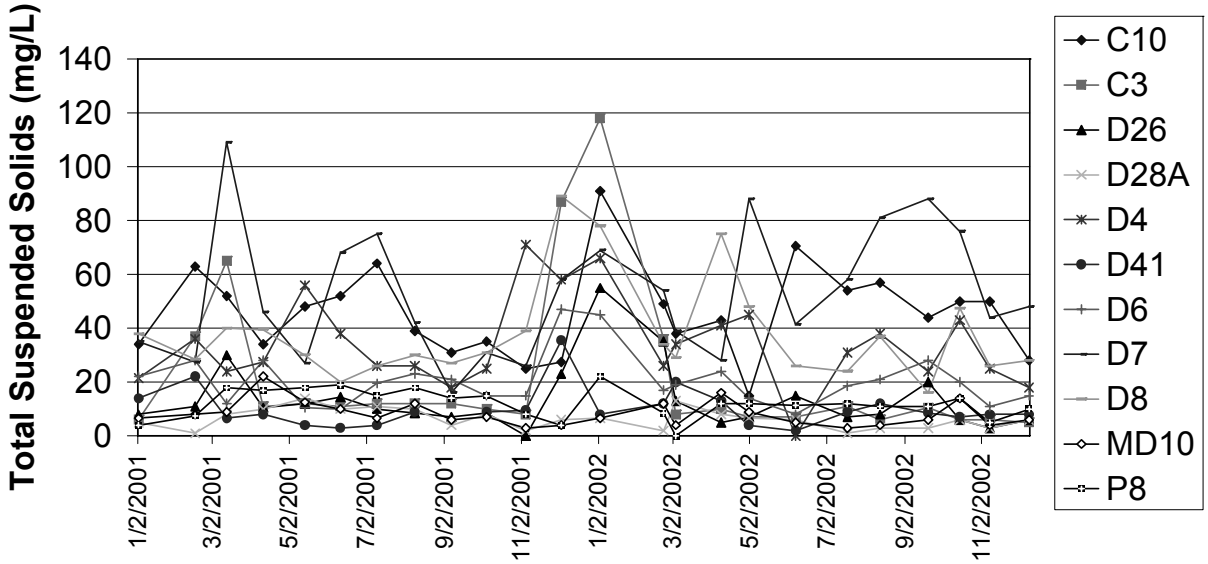

Figure 3-25 Total suspended solids at specific Bay-Delta sampling sites, 2001-2002

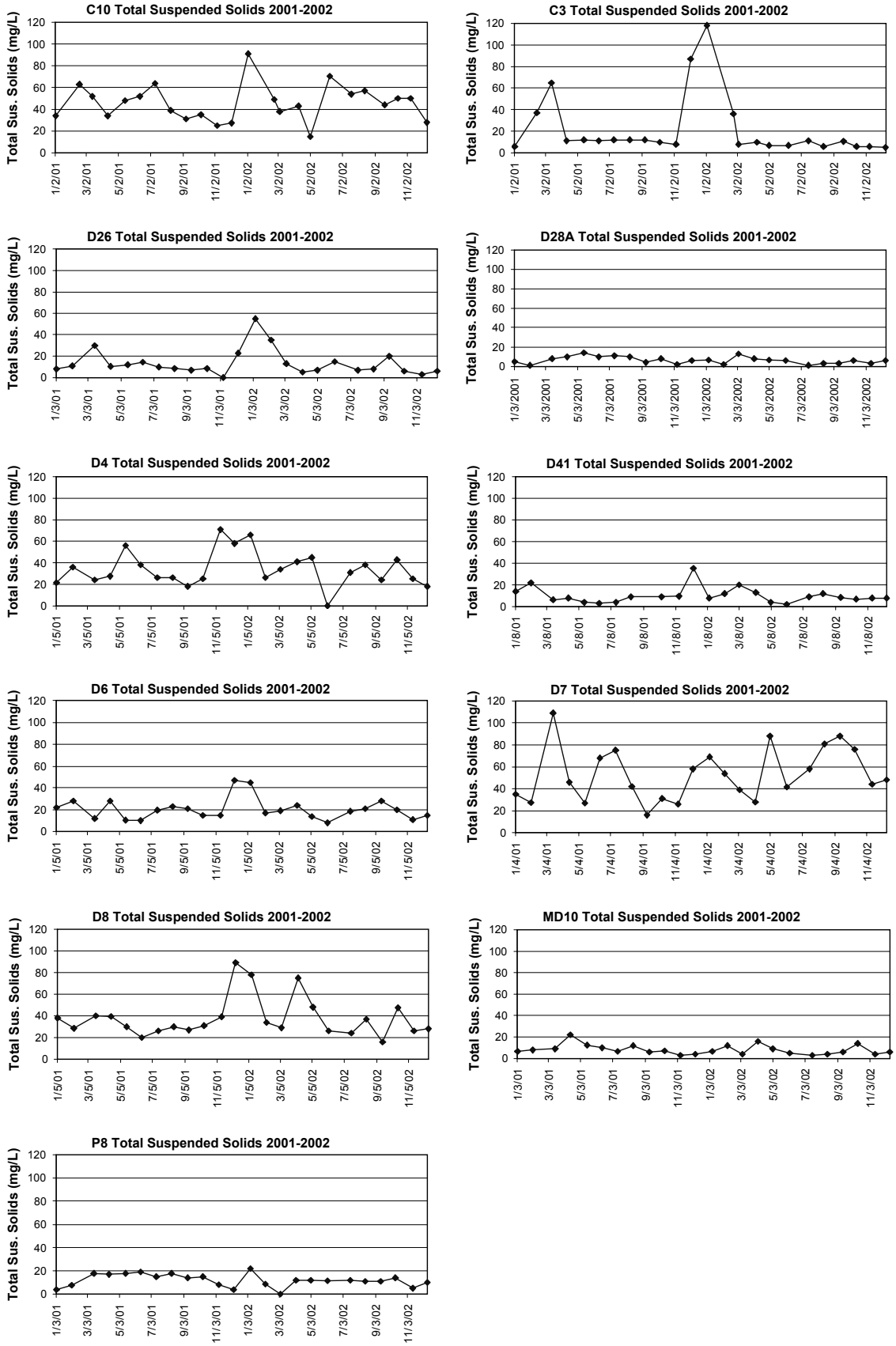

Figure 3-26 Volatile suspended solids—comparison of Bay-Delta sampling sites, 2001-2002

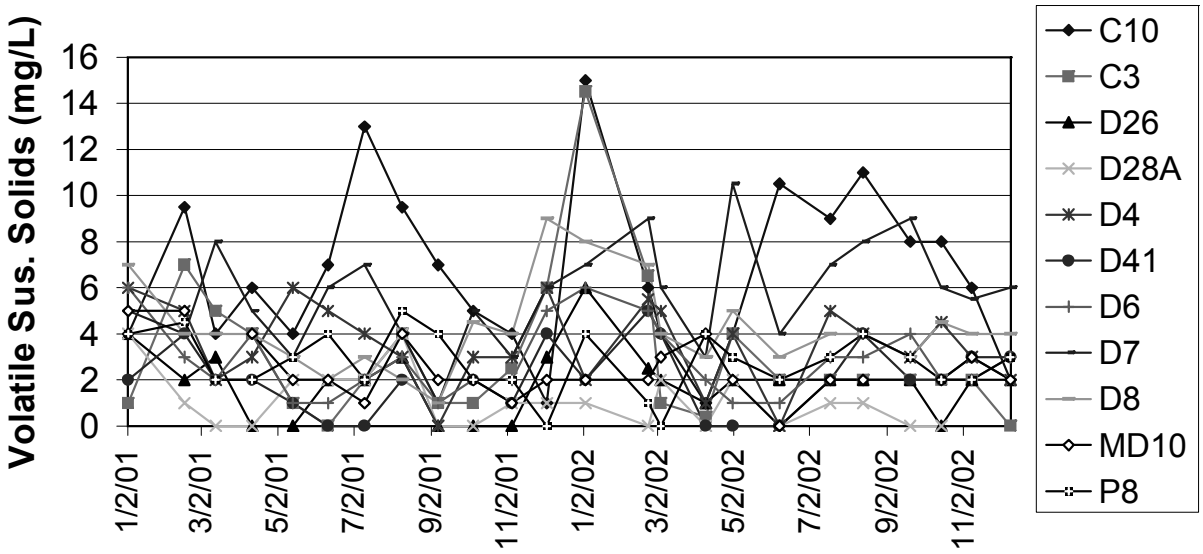

Figure 3-27 Volatile suspended solids at specific Bay-Delta sampling sites, 2001-2002

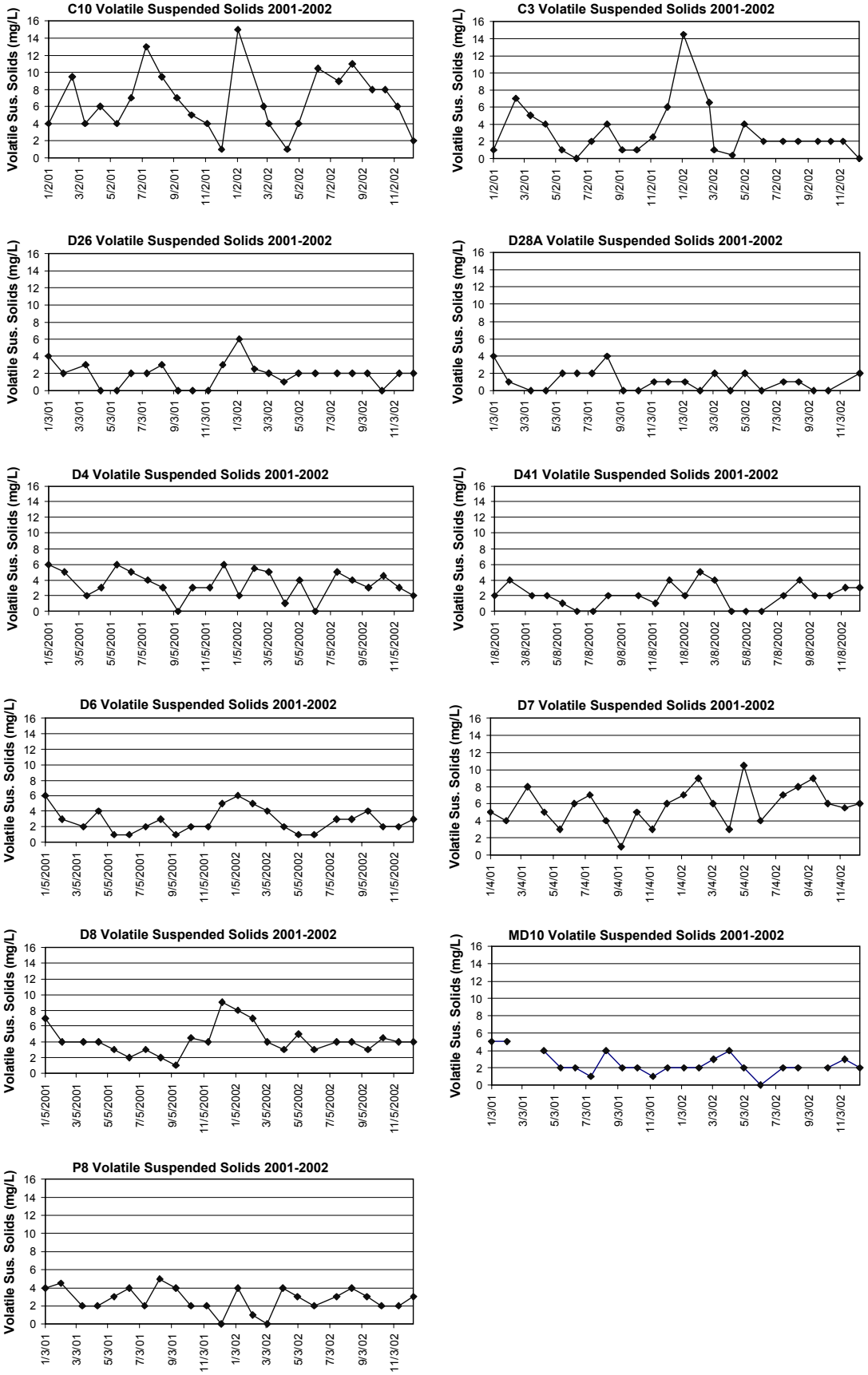

Figure 3-28 Silica concentrations—comparison of Bay-Delta sampling sites, 2001-2002

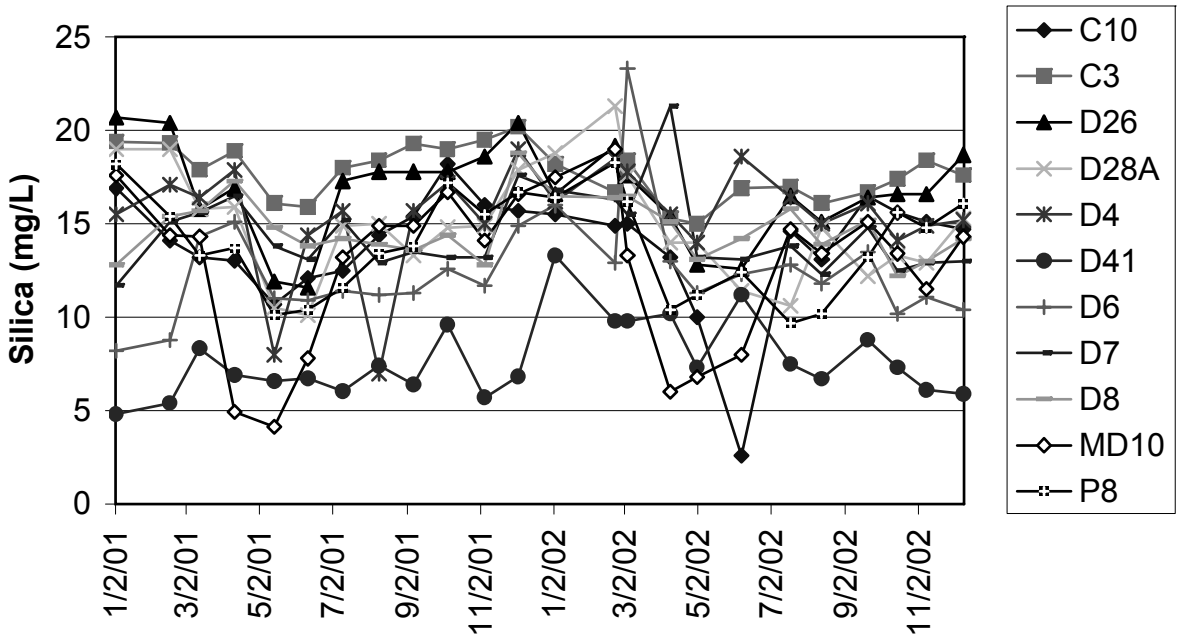

Figure 3-29 Silica concentrations at specific Bay-Delta sampling sites, 2001-2002

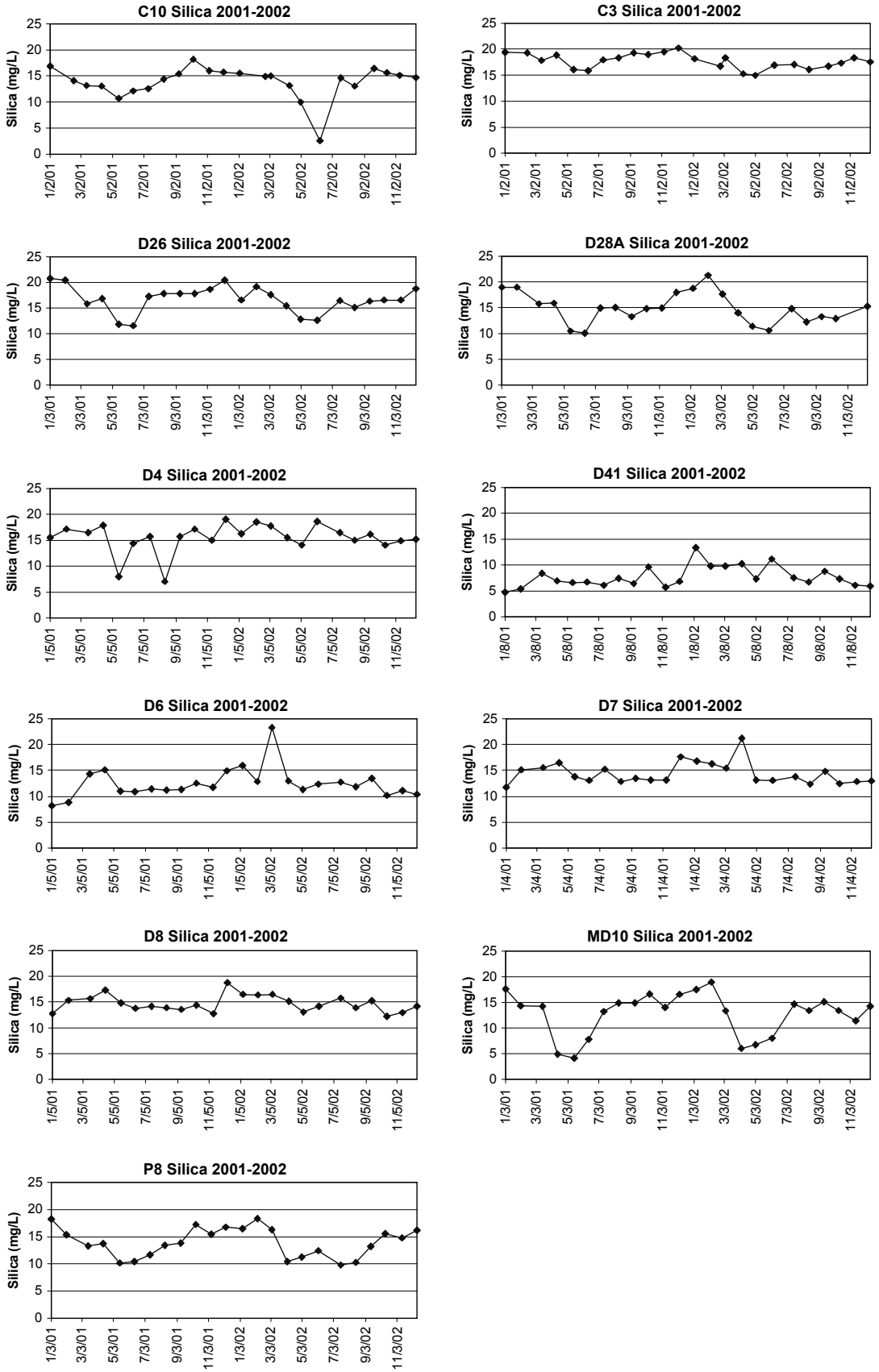

Figure 3-30 Chloride concentrations—comparison of Bay-Delta sampling sites, 2001-2002

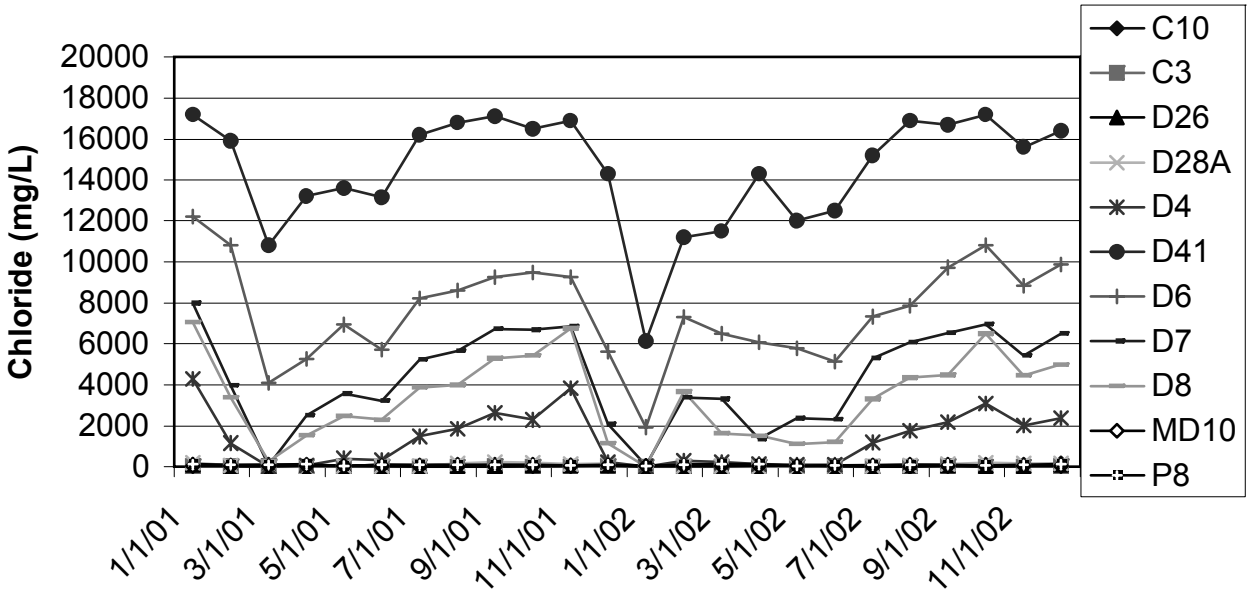

Figure 3-31 Chloride concentrations at specific Bay-Delta sampling sites, 2001-2002